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This teacher's manual is one of a series of instructional aids prepared by the Department of Agricultural Education at the Pennsylvania State University. It include s suggestions and references for the teacher to use with the student manual, available as VT 008 460. In addition to the subject material in the student manual, pages are inserted at the end of each problem area containing suggestions, references, resource people, audio-visual aids, suggested learning activities, and suggested placement experiences, if applicable. A unit examination is available at the end of the document. (DM)

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Turfgrass
Maintenance and Establishment

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A Teacher's Manual

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Illustrations, many of the photographs, and an accompanying series of color slides were largely the work of Christopher Shelly, Gerald Seiler, and Richard Tenney, Graduate Assistants, Department of Agricultural Education. Many photographs were supplied by Tom Mascaro of West Point Products, Inc.

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Introductory Statement

This Turfgrass Maintenance and Establishment, A Teacher's Manual, is one of a series of instructional aids being prepared and edited by the Department of Agricultural Education through a contractual agreement between The Pennsylvania State University and the United States Office of Education, Division of Adult and Vocational Research. In addition to the development of instructional aids, the contract provided for two teachers' institutes in landscape horticulture. These were held July 5-22, 1966, and July 3-21, 1967.

The fifty-four teachers from the northeastern states who participated in the teachers' institutes were asked to evaluate and help improve the organization and the content of this instructional aid. They field-tested the unit with classes in landscape horticulture in their schools.

An advisory committee has provided guidance in the selection of areas of emphasis for which several units of instruction in landscape horticulture have been prepared. The committee has assisted by outlining key problem areas and by suggesting important subject matter information to be included in the content of each unit. In addition to Joseph M. Duich, Donald V. Waddington, John C. Harper, II, H. Burton Musser, George J. Shoop, and Walter I. Thomas, who have been cited previously, the following persons have served in an advisory capacity to the development of this unit of instruction: Virgil E. Christensen, Center for Vocational and Technical Education, 980 Kinnear Road, Ohio State University, Columbus; and Alvan F. Frank, Head, Farm Placement, Bureau of Employment Security, Department of Labor and Industry, Harrisburg, Pennsylvania.

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David R. McClay, Associate Project Director
Glenn Z. Stevens, Associate Project Director

NOTE TO THE TEACHER

This Teacher's Manual consists of the Student Handbook plus suggestions to the teacher. Suggestions to the teacher have been printed on green sheets and incorporated at the end of each problem area. In planning to teach a problem area the teacher may wish to proceed as follows:

1. Read the student material.
2. Obtain some or all of the references recommended.
3. Select and order visual aids.
4. Read the suggested student learning activities and plan to use those which seem appropriate.

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PROBLEM AREA I

EXPLORING JOB OPPORTUNITIES IN TURFGRASS BUSINESSES

Student Learning Objectives

1. To explore employment opportunities in turf occupations.
2. To learn the employment outlook, nature of the work, and personal qualifications needed for turf occupations.

Key Questions

1. What types of jobs are available in turf industries or businesses?
2. What are the special interests, aptitudes, and physical abilities needed for employment in turf occupations?
3. What level of education, training, and experience is needed for entrance and advancement in turf occupations?
4. What job opportunities in turf maintenance and establishment exist within commuting distance of your school?

Turf Occupations

During the past 10 years the number of people employed to establish and maintain home and industrial lawns, cemeteries, parks, golf courses, and athletic fields has increased rapidly. A recent survey of Pennsylvania indicates that the annual maintenance cost for turf of all types (home lawns, highways, sod farms, golf courses, schools, institutions, cemeteries, and parks) is about $565,000,000 for about 963,600 acres of turfgrass. Probably about 16,750 people are employed in this work in Pennsylvania. The occupations in the area of turfgrasses may be broadly classified as:

1. Professional
    a. Extension Agronomist (Turfgrass Specialist)
    b. Agronomist
2. Managerial
    a. Golf Course Superintendent
    b. Athletic Field Superintendent
    c. Landscape Contractor
3. Technical
    a. Assistant Golf Course Superintendent
    b. Turf Supplies Salesman

4. Service Workers
    a. Greensworker
    b. Landscape Gardener
    c. Groundskeeper
    d. Athletic Field Groundskeeper

This classification generally reflects the nature of the work as well as the educational requirements for the occupation. For additional references, see Careers in Ornamental Horticulture, Reference No. 4, Careers in Agribusiness and Industry, Reference No. 5, and Handbook of Agricultural Occupations, pp. 187-212, Reference No. 12.

Extension Agronomist (Turfgrass Specialist)

An extension agronomist is responsible for planning, developing, and evaluating programs in all phases of turf culture and management throughout his state. A county extension agent usually asks an extension agronomist for help when special turfgrass problems develop. The turfgrass specialist works directly with supervisors or managers in turf industries or businesses. Making fertility recommendations from soil test data may be a major part of his work. Other duties may include preparing leaflets, pamphlets, and bulletins on turfgrasses. Extension specialists also make presentations at professional and educational meetings.

An extension agronomist has at least a master's degree in agronomy, and preferably a Ph.D. Being able to meet and work well with people is also very important.

The starting salary for men with a master's degree is approximately $7,000 to $9,000 per year and men with a Ph.D. usually start at $10,000 to $12,000 per year.

Agronomist

An agronomist may teach and do research in turfgrass. He may conduct experiments to improve the quality of turfgrass through breeding, environmental control, and cultural techniques. He studies soils, (structure and fertility), climate, (seasons, temperatures, rainfall, relative humidity, and sunlight), and adverse factors, (plant diseases, insects, and weeds).

In an industrial company his primary jobs are conducting research, demonstrations, and/or sales promotion.

At a university an agronomist in turfgrass conducts research and teaches courses in turfgrass management. For permanent employment at a university an agronomist would have to hold a Ph. D. which requires about 7 years of collegiate study.

Federal and state governments sometimes have openings for people having advanced degrees in this field.

Starting salaries range from $7,000 to $9,000 per year, with a Master's degree, and about $10,000 to $12,000 per year with the Ph. D.

Golf Course Superintendent

A golf course superintendent supervises and coordinates the activities of workers on the course. He is responsible for improving and maintaining the turf without interrupting play on the course. In addition to managing the turf he is responsible for interviewing, hiring, and training employees; keeping employee records; preparing budgets and reports; purchasing materials and equipment; and maintaining equipment.

Much of the golf course superintendent's work is outdoors. During the growing season he may work 10 to 16 hours a day.

A two-year post-high school short course in turf is desirable training for this job. Many men become golf course superintendents through 5 to 10 years of practical experience as an assistant superintendent or greensworker.

More golf course superintendents are needed to maintain new courses being constructed. Their beginning salaries range from $5,500 to $7,000 per year.

Athletic Field Superintendent

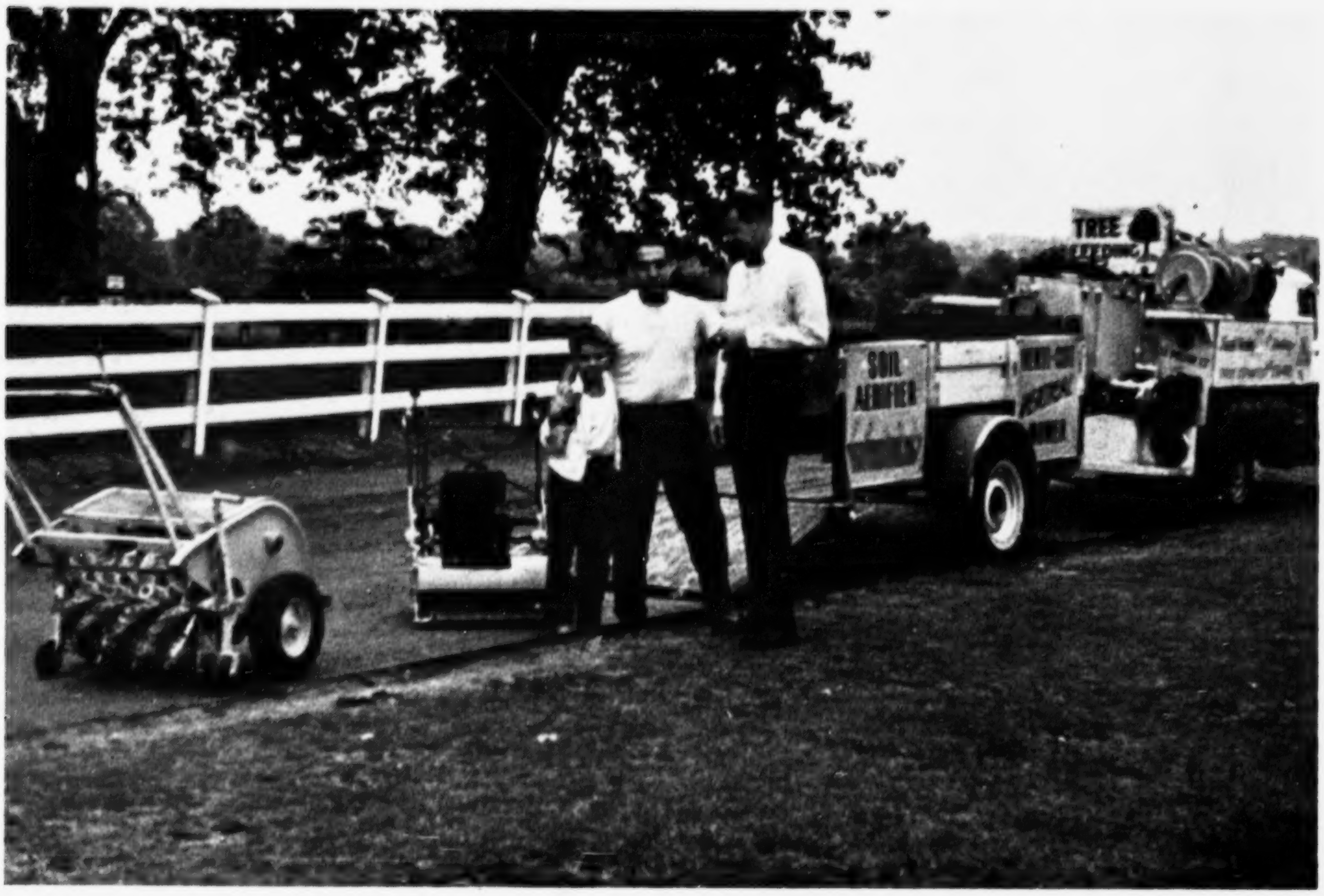
The athletic field superintendent directs workers in maintaining a field for sporting events such as baseball and football games. He is responsible for the maintenance of playing and practice fields. His duties include lining and marking the playing areas, setting goalposts, and maintaining the turfgrass.

The superintendent interviews, hires, and trains employees. He keeps employee records, prepares budgets and reports, purchases equipment and supplies, and directs the maintenance of all equipment.

Much of the work of the athletic field superintendent is performed outdoors. Seasonal sporting events may cause long working hours during the playing season.

A two-year post-high school short course in turf management is desirable for this job. Athletic field superintendents usually have had 3 to 5 years' work experience before becoming a superintendent.

Starting salaries range from $5,500 to $7,000 per year.



Landscape Contractor

The landscape contractor establishes and maintains turf and shrubbery on properties according to a landscape plan. He estimates costs and bids for landscaping jobs. He supervises and coordinates workers who maintain or establish the landscapes of homes and businesses. He may make decisions regarding establishment and cultural practices to use, such as type of seed, amount and grade of fertilizer, and the way to plant and prune shrubbery. He also makes decisions about purchasing equipment and he must see that the equipment is maintained properly.

During winter the landscape contractor sells his services by renewing old contracts and contacting potential customers. He also may contract for snow removal.

Many landscape contractors are self-employed. It is difficult to estimate the salary or wages of self-employed persons. His income will depend upon his initiative, experience, and ability.

Many colleges have a two-year course in ornamental horticulture and turf. The course is valuable training for a landscape contractor.

Assistant Golf Course Superintendent

The assistant superintendent must be able to supervise workers and perform certain jobs himself. With the superintendent, he (1) determines work priority, (2) assigns workers to specific jobs, and (3) demonstrates tasks to workers. He needs to be skilled in (1) calibrating fertilizer and spray equipment, (2) applying lime, fertilizer, and pesticides, (3) operating irrigation equipment, (4) operating mowers, aerifiers, vertical mowers, (5) cleaning and grading sand traps, (6) changing putting cups and tee markers, (7) establishing new sod where needed, (8) topdressing, poling, and syringing the greens, (9) pruning and spraying trees and shrubs, and (10) servicing and repairing all equipment. He helps the superintendent keep records and prepare budgets and reports.

The assistant superintendent has irregular working hours. Some maintenance must be done during early morning, late evening or night so as not to interfere with play on the course.

The demand for capable and responsible assistant superintendents is good. He can expect an average salary of $400 to $500 per month.

Turf Supplies Salesman

Many job opportunities are available as a salesman of turf supplies and equipment. Seeds, fertilizers, insecticides, herbicides, and fungicides are examples of turf supplies; and mowers, aerifiers, irrigation systems, and small tools are examples of equipment used in turf culture.

The salesman calls upon individuals or businesses to show his products. He provides performance - and use - information and takes orders for his products. He may instruct the dealer or golf course superintendent in the use of the equipment and supervise its installation. The salesman is often involved in sales promotions advertising the product through displays or exhibits.

The salesman is usually assigned to a district and may have to travel extensively. An aptitude for selling and working with people is necessary for this occupation. A high-school education and two or more years of formal training are usually required. Experience in working with the products being sold is highly desirable.

A salesman can expect a beginning salary of $500 a month plus commission. In individual cases the salary may be much higher.

Greensworker

The greensworker performs many tasks to maintain the grounds and turf of a golf course. A greensworker operates mowers, aerifiers, vertical mowers, and other power equipment. He applies lime, fertilizer, and pesticides at rates prescribed by the superintendent. The greensworker cleans and grades sand traps, changes putting cups and tee markers, topdresses, poles, and syringes greens. He also may prune and spray trees and shrubs, service equipment, and maintain buildings and other structures.

To enter this occupation you should like growing plants and working outdoors. You can gain experience by working at a golf course during the summer months. It is desirable to take courses emphasizing turf management while in high school. After 3 to 5 years of part-time experience plus training in technical turf courses, you may qualify for the position of assistant superintendent. The need for greensworkers is seasonal. The average wages received are $1.40 to $2.00 per hour. Working hours will be irregular since some work must be done in early morning, late evening, or at night. The job of greensworker is the starting point for advancement to the position of assistant superintendent or superintendent.

Landscape Gardener

The landscape gardener may work for a landscape contractor, or he may be self-employed. Most of the work is outdoors during the spring, summer, and fall months. Working as a landscape gardener primariliy involves the actual work of establishing and maintaining the landscapes around properties. Preparing a seedbed, applying fertilizer, and seeding turf areas are examples of the work involved in establishing turf areas. Applying fertilizer, mowing grass, and pruning shrubs are examples of the work in maintaining turf areas. Many high school boys gain experience by working during the summer as a landscape gardener. The starting wages are approximately $1.40 per hour. With experience and initiative, a person may become a foreman of a crew of workers and receive wages as high as $2.25 per hour.

A high-school education with courses in vocational agriculture or ornamental horticulture is desirable for a landscape gardener. A knowledge of plants, soils, fertilizers, and pesticides is important. Mechanical skills are needed to operate and maintain the equipment used on the job.

Groundskeeper

A groundskeeper is employed to maintain the grounds of industrial, commercial, or institutional properties. He performs a number of tasks, including (1) mowing and trimming the lawn, (2) fertilizing turf and shrubs, (3) spraying turf and trees with insecticides, (4) watering turf and shrubs during dry periods, (5) clearing snow in winter, and (6) doing minor repair work on fences, gates, and buildings.

A high-school education including instruction in plant science and mechanics science is desirable for a groundskeeper. The work requires a knowledge of plants and how they grow; the use of fertilizers and pesticides; and the maintenance of the equipment used on the job.

While in high school, part-time work as a service worker in grounds maintenance is a good way to gain experience. Advancement will depend upon the employee's knowledge of his work and his willingness to accept responsibility. He can increase his knowledge by enrolling in turf short courses and correspondence courses. The work may be seasonal, except where the property is large. Wages received by employees range from $1.40 to $1.75 per hour.

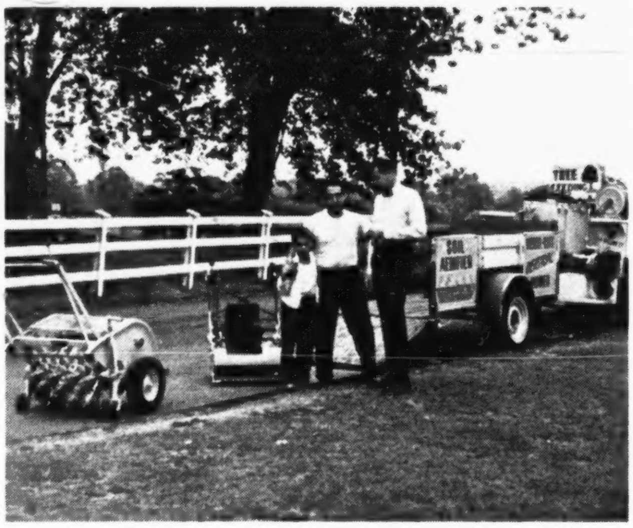
Athletic Field Groundskeeper

The athletic field groundskeeper prepares the race track or athletic field for sporting events. His work is primarily outdoors and directed by a superintendent. He may perform any combination of the following tasks on playing and practice fields such as (1) mowing the turf with power mowers, (2) operating irrigation equipment, (3) smoothing the track or infield with power and hand equipment, (4) applying lime, fertilizer, and pesticides to the playing fields and grounds, (5) aerifying and vertical mowing the turf, (6) marking the field lines with paint or chalk, (7) positioning goal posts and other necessary equipment, and (8) servicing and repairing equipment and facilities.

A high-school education is desirable. Short courses or correspondence courses in turf will be beneficial. To advance to the position of grounds supervisor, a two-year winter course in turf management would be desirable.

Wages received vary from $1.40 to $2.25 per hour.

It is not easy to choose a career or occupation. Perhaps "Problem Area 1: Exploring Job Opportunities in Turfgrass Businesses" has helped you make a choice. Were some of the jobs described interesting? Have you explored your interests and abilities? Can you meet the educational requirements of the job? When you have decided on a career, you will be on the way to a successful and happy future.



Test

1. Landscape gardeners and groundskeepers usually perform tasks other than maintaining or establishing turfgrasses. What are some of these tasks?
2. What are the educational requirements for technical occupations?
3. What are the aptitudes necessary to be a turf-supplies salesman?
4. List two technical occupations in the turfgrass industry.
5. List the responsibilities of a golf course superintendent.
6. How much education is usually needed to enter professional occupations in the turfgrass industry?
7. List two professional occupations in the turfgrass industry.

SUGGESTIONS AND REFERENCES FOR THE TEACHER

Learning Resources

References:

Careers in Ornamental Horticulture, Reference No. 4.

Careers in Agribusiness and Industry, Reference No. 5.

Handbook of Agricultural Occupations, Reference No. 12.

Resource People:

Highway Maintenance Supervisor, Landscape Contractor, University Extension Specialist, Golf Course Superintendent, County Agent, and Athletic Field Superintendent.

Audio Visual Aids:

"Exploring Occupations in Turfgrass," 30 color slide series, Department of Agricultural Education, The Pennsylvania State University, University Park, Pennsylvania. Approximate cost $5.50.

Suggested Student Learning Activities

1. Research has shown that many occupational opportunities exist in the area of turfgrass establishment and maintenance at all levels of employment. Job opportunities exist for those with a high school education, a two-year associate degree, or a college degree. The following factors should be considered when choosing an occupation. Discuss each factor with the students:
    a. What is the nature of the work? What are the tasks to be performed?
    b. Does the occupation require mental or physical effort?
    c. Does the individual's health meet the requirements of the work?
    d. Is the work performed indoors, outdoors, or both?
    e. What personal qualifications are needed to enter the occupation?
    f. What are the educational and training requirements for the occupation?
    g. Is there opportunity for doing a variety of jobs?
    h. Will the job require considerable travel and time away from home?
    i. What salary or wage may be earned in the occupation?
    j. Are there "fringe" benefits provided by the employer?
    k. What security is offered in the occupation?
    l. Are there opportunities for advancement?

   m. Is the employment on a regular or seasonal basis?
   n. What are the working hours?
   o. With what type of persons will you be working?

2. Use the 2" x 2" color slide series "Exploring Occupations in Turfgrass" to acquaint students with the various types of jobs available.
3. Discuss the qualifications required for filling the various job requirements indicated in the slides.
4. Have students complete the occupational profile chart as a homework assignment. Transcribe the chart on the chalkboard. Complete it with student responses.
5. Invite men working in turfgrass occupations to the class. Have them discuss factors to consider when choosing an occupation, as outlined previously, with the class. Encourage personal discussions between the students and the employees or employers. Students' questions may be outlined in the class prior to the visit by the resource person.
6. Plan a field trip to a golf course to give students a first-hand look at the working conditions. Use the Field Trip Observation Record as a guide for the class discussion with the golf course superintendent.

OCCUPATIONAL PROFILE CHART

Occupation	Regular Income?	Regular Hours?	Work Indoors? Outdoors?	Offers Variety of Work?	Great Deal of Travel Required?	Work in One Place?	Fringe Benefits?	Work With Others?	Desirable Educational Requirements?
Extension Agronomist (Turfgrass Specialist)	______	______	______	______	______	______	______	______	______
Agronomist	______	______	______	______	______	______	______	______	______
Golf Course Superintendent	______	______	______	______	______	______	______	______	______
Athletic Field Superintendent	______	______	______	______	______	______	______	______	______
Landscape Contractor	______	______	______	______	______	______	______	______	______
Assistant Golf Course Superintendent	______	______	______	______	______	______	______	______	______
Turf Supplies Salesman	______	______	______	______	______	______	______	______	______
Greensworker	______	______	______	______	______	______	______	______	______
Landscape Gardener	______	______	______	______	______	______	______	______	______
Groundskeeper	______	______	______	______	______	______	______	______	______
Sports Groundskeeper	______	______	______	______	______	______	______	______	______

PROBLEM AREA 2

KINDS OF TURFGRASSES AND THEIR USE

Student Learning Objectives

1. To learn the characteristics that aid in distinguishing the grass species used for turf.
2. To be able to identify the turfgrasses commonly used in northeastern United States.
3. To know some of the growth habits and cultural requirements of these turfgrass species.

Key Questions

1. Why is identification so very important?
2. On what basis are turfgrasses identified?
3. Which of the turfgrasses are best suited for home lawns? Athletic fields? Golf greens? Highway shoulders?

New Words

Annual - living for one year or season

Biennial - a plant that has only leaves the first season, produces flowers the second season, and then dies

Characteristic - distinguishable parts or behavior

"Green manure" - a plant grown to be plowed into the soil to increase the organic matter content of the soil

Leaflets - small leaves making up parts of a larger compound leaf

Perennial - a plant which lives for more than two years

Persist - last or exist

Serviceable - useful; wear resistant

Species - a true-breeding, identical group of plants

Strain - a special selection from a species

Texture - leaf width, length, and stiffness

Variety - a true-breeding strain

Identifying and Determining the Use of Turfgrasses

Good maintenance practices will assure that a well-established lawn will continue to be beautiful and serviceable for many years. Establishment of a good lawn includes proper grading, good seedbed preparation, the proper seed mixture, correct fertilization, and adequate care until a dense, dark-green, weed-free turf has been obtained.

Good maintenance includes appropriate attention to many things. The grass must be properly mowed; the fertility must be maintained; and weeds must be controlled. Application of water at the time it is needed is also important.

Learning the cultural requirements of different species and varieties of turfgrasses is important. For example, Merion Kentucky bluegrass must be maintained differently than common Kentucky bluegrass. Merion Kentucky bluegrass grows more vigorously, requires higher levels of fertility, and can be mowed shorter than common Kentucky bluegrass. Both turfgrasses make good lawns if they are properly maintained.

You should be able to identify a few of the more common lawn grasses, so you will know the right maintenance practices to follow. In northeastern United States, some of the more popular species of turfgrasses are the bluegrasses, fescues, and bentgrasses. Ryegrass, redtop, and crownvetch are also adapted and often used for special purposes.

Drawings of a grass plant and some of its vegetative characteristics used in turfgrass identification are shown on pp. 20 and 21. The characteristics of a number of important turfgrasses together with illustrations of them are also given in this Problem Area. You may want to read about turfgrasses in greater detail in Turfgrass Guide, p. 1-4, Reference No. 17.

A general description of each of the major turfgrasses and a description of crownvetch is given on pp. 22 and 23. Identifying characteristics and pictures begin on p. 25.

Vegetative Characteristics of Turfgrasses

I. Leaf

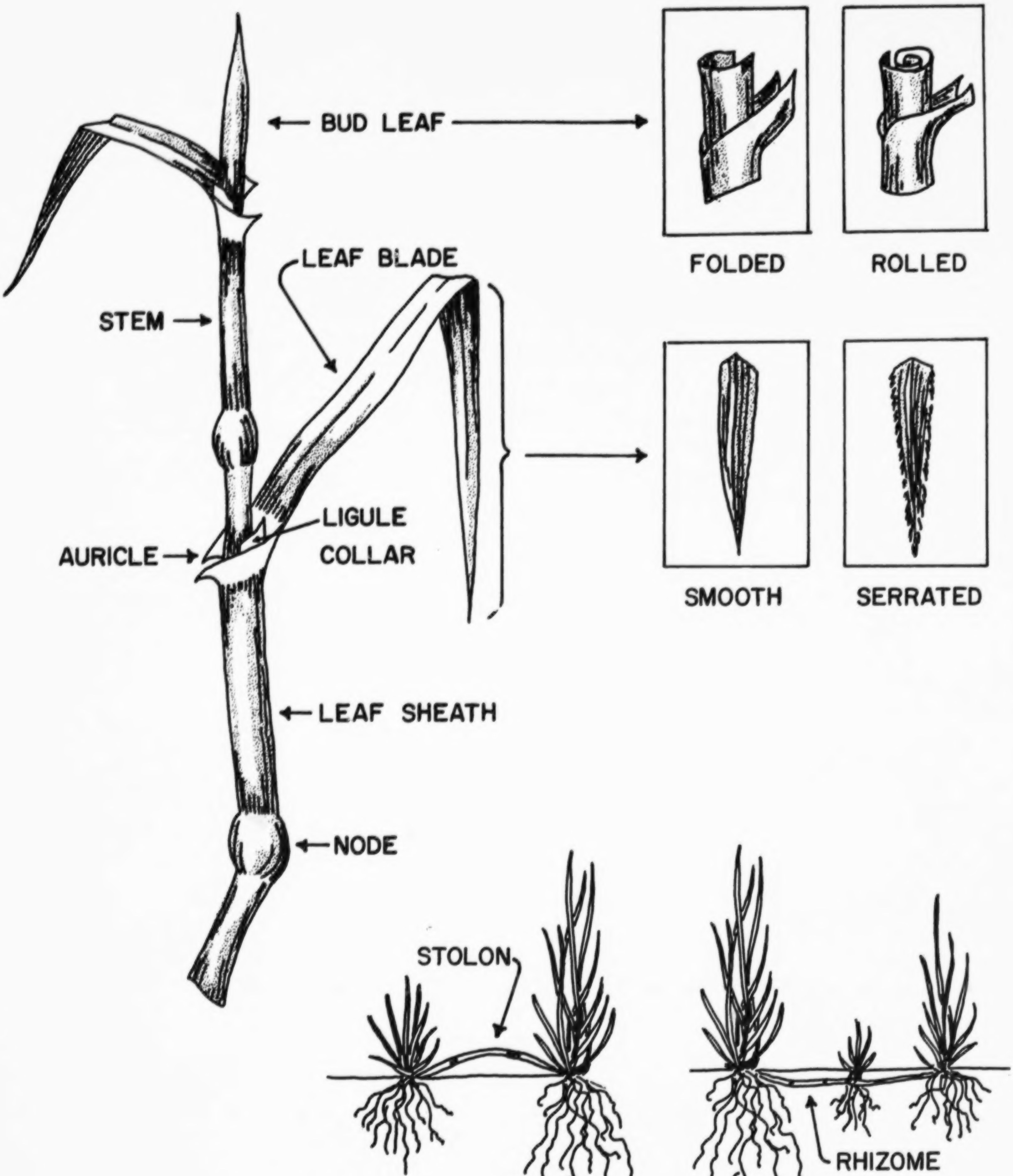
- A. Blade - upper part of the leaf extending away from the stem.
    - 1. Margin
        - a. serrated - saw-tooth edge
        - b. entire - smooth
- B. Sheath - lower part of the leaf enclosing the stem. Where the blade and the sheath meet, one or more of the following characteristics may be found:
    - 1. Collar - thickened ridge on the underside of the leaf at the junction of the blade and sheath.
    - 2. Ligule - a curtain-like appendage on the top side of the leaf at the junction of the blade and sheath. (It may be parchment-like - meaning brown and dried)
    - 3. Auricles - finger-like projections on each side of the leaf at the junction of the blade and sheath.

II. Bud leaf - youngest or topmost leaf on a developing stem. The leaf in the bud stage may be either:

- A. Rolled in the bud.
- B. Folded in the bud.

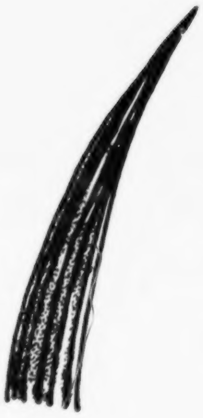
III. Stem - long, hollow cylinder interrupted by nodes (joints). The stem supports the leaves. A grass species may or may not have:

- A. Rhizomes - modified stems that grow underground. As they grow away from the plant, they root at the nodes and produce new plants.
- B. Stolons - modified stems that grow above ground. Stolons have a creeping habit of growth. When a stolon touches the ground it roots at a node and produces a new plant.


BUD LEAF
FOLDED
ROLLED
LEAF BLADE
STEM
SMOOTH
SERRATED
LIGULE
AURICLE
COLLAR
LEAF SHEATH
NODE
STOLON
RHIZOME

PARTS OF A GRASS PLANT

TIPS OF LEAF BLADES



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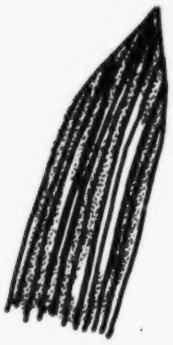

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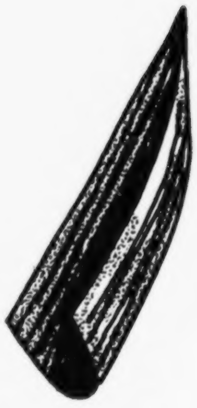
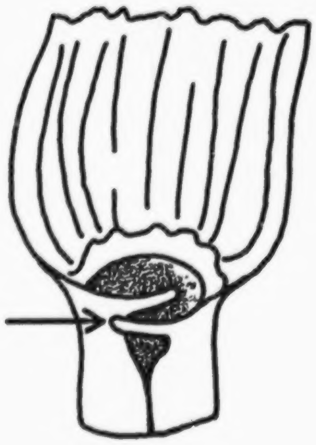
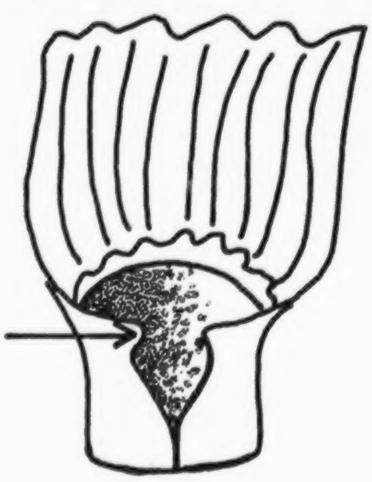


BOAT-SHAPED

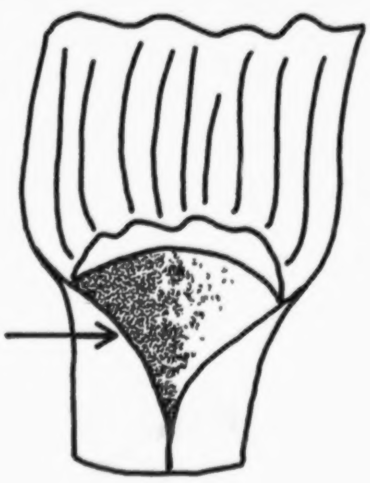
AURICLES



CLAW-LIKE

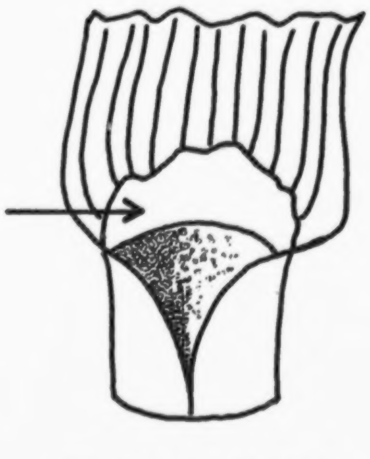


ROUNDED OR RUDIMENTARY

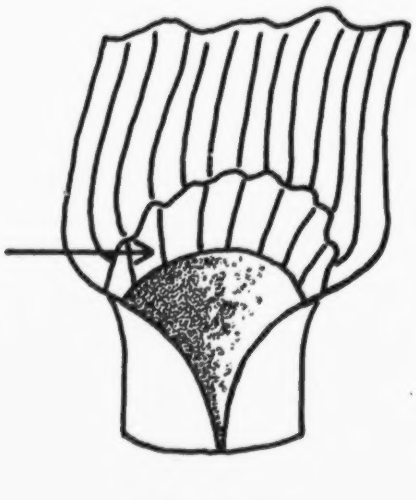


ABSENT

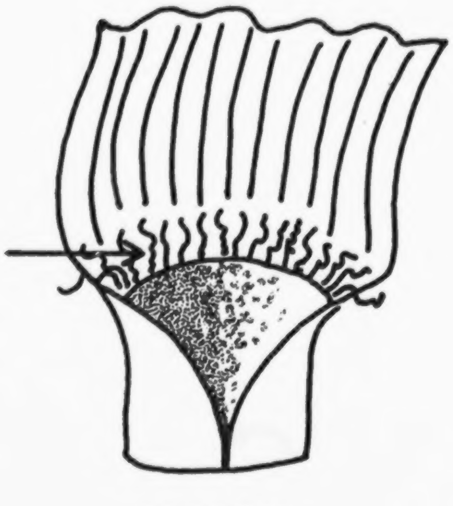
LIGULES



MEMBRANOUS SMOOTH



CRIMPED



FRINGE OF HAIRS

Bluegrasses (Poa species)

Bluegrasses (annual or perennial), of which there are a number of species, may be seeded along or combined with other grasses in the Northeast. They are the most popular grasses used in common lawn mixtures. They are used in seed mixtures for fairways, lawns, and athletic fields. Bluegrass species may be most easily identified by their boat-shaped leaf tip.

Fescues (Festuca)

Fescues are usually divided into two groups according to their vegetative characteristics. Tall fescue is a coarse-leaved perennial grass. The red fescues are also perennial and are characterized by fine bristle-like leaves. The seed heads of all fescues are similar.

Bentgrasses (Agrostis species)

The bentgrasses are used primarily on golf course greens and sometimes on tees and fairways. Generally, these grasses require fertile soils and intensive management. With proper management, they may be mowed to heights of 3/8 to 3/4 of an inch. Redtop is an exception in the Agrostis group. It is used primarily as a temporary grass. Bentgrasses may be identified by the following characteristics: (1) rolled in the bud, (2) prominent leaf veins, and (3) leaf with pointed tip.

Ryegrasses (Lolium species)

Italian ryegrass (Lolium multiflorum), which is often called annual ryegrass, and perennial ryegrass (Lolium perenne) are two closely related ryegrass species. Italian ryegrass is an annual, but perennial ryegrass will live 4 or 5 years under favorable growing conditions. Seed sold as domestic ryegrass may contain a mixture of annual and perennial ryegrass.

Both Italian and perennial ryegrass are coarse-textured bunch grasses. They form turfs very similar in appearance. They germinate quickly and may be seeded in mixtures or alone. In mixtures, they are used to provide groundcover while the slower-growing, permanent grass species are becoming established. If over 15 percent ryegrass is included in the grass mixture, it may hinder the establishment of the permanent grasses. The "Norlea" variety is recommended for seed mixtures.

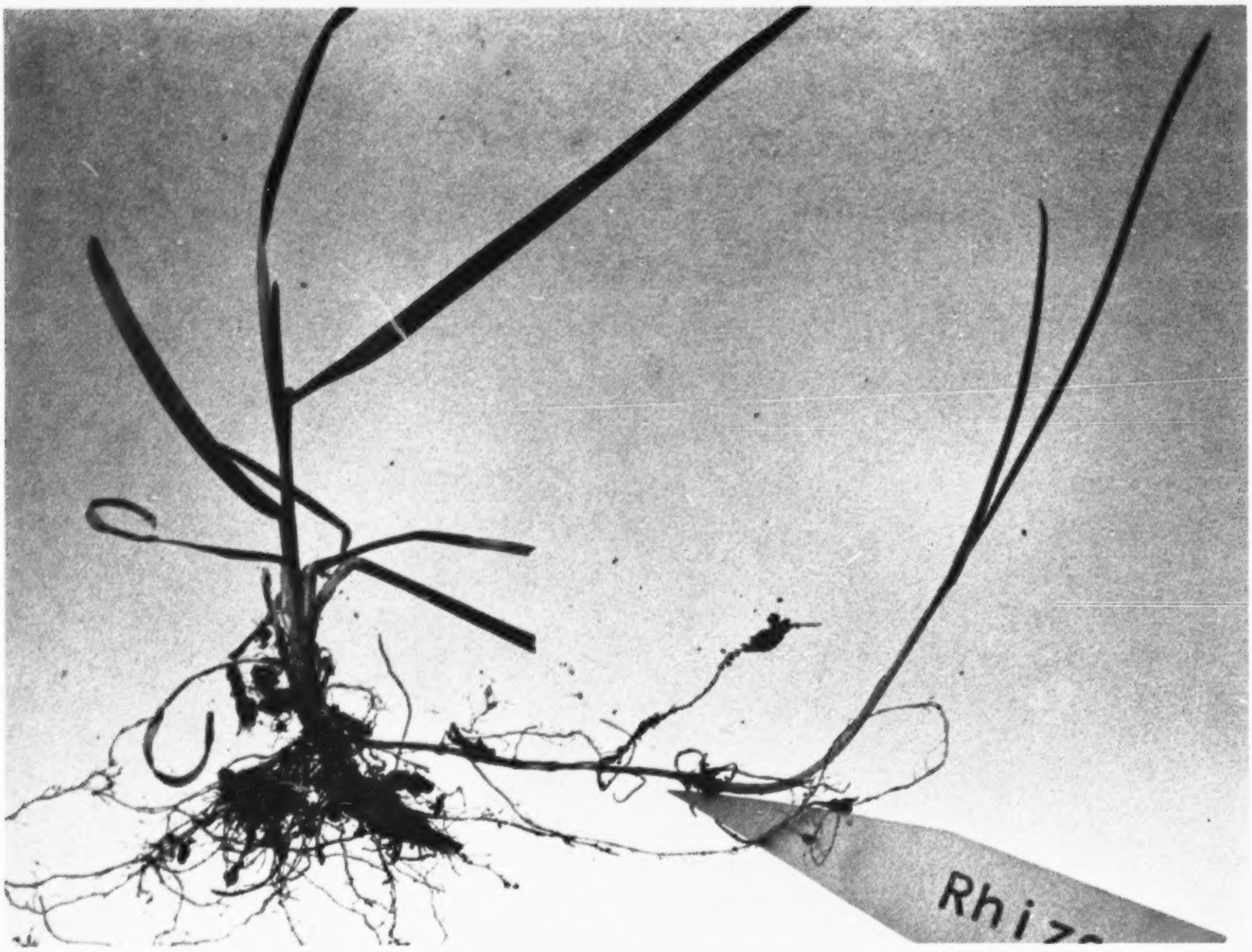
The ryegrasses require well-drained soils with good moisture-holding capacity. They grow best on fertile soils with higher pH levels (6.5 to 7.0). Ryegrasses cannot stand prolonged periods of hot dry weather.

Crownvetch (Coronilla varia L.)

Crownvetch is not a grass, but a perennial legume used on steep slopes, particularly along highways, for erosion control and beautification. It spreads by fleshy rhizomes. It has a deep branched root system. The foliage produces a solid green mat throughout the growing season. Crownvetch has pink, purple, or white flowers from June to August.

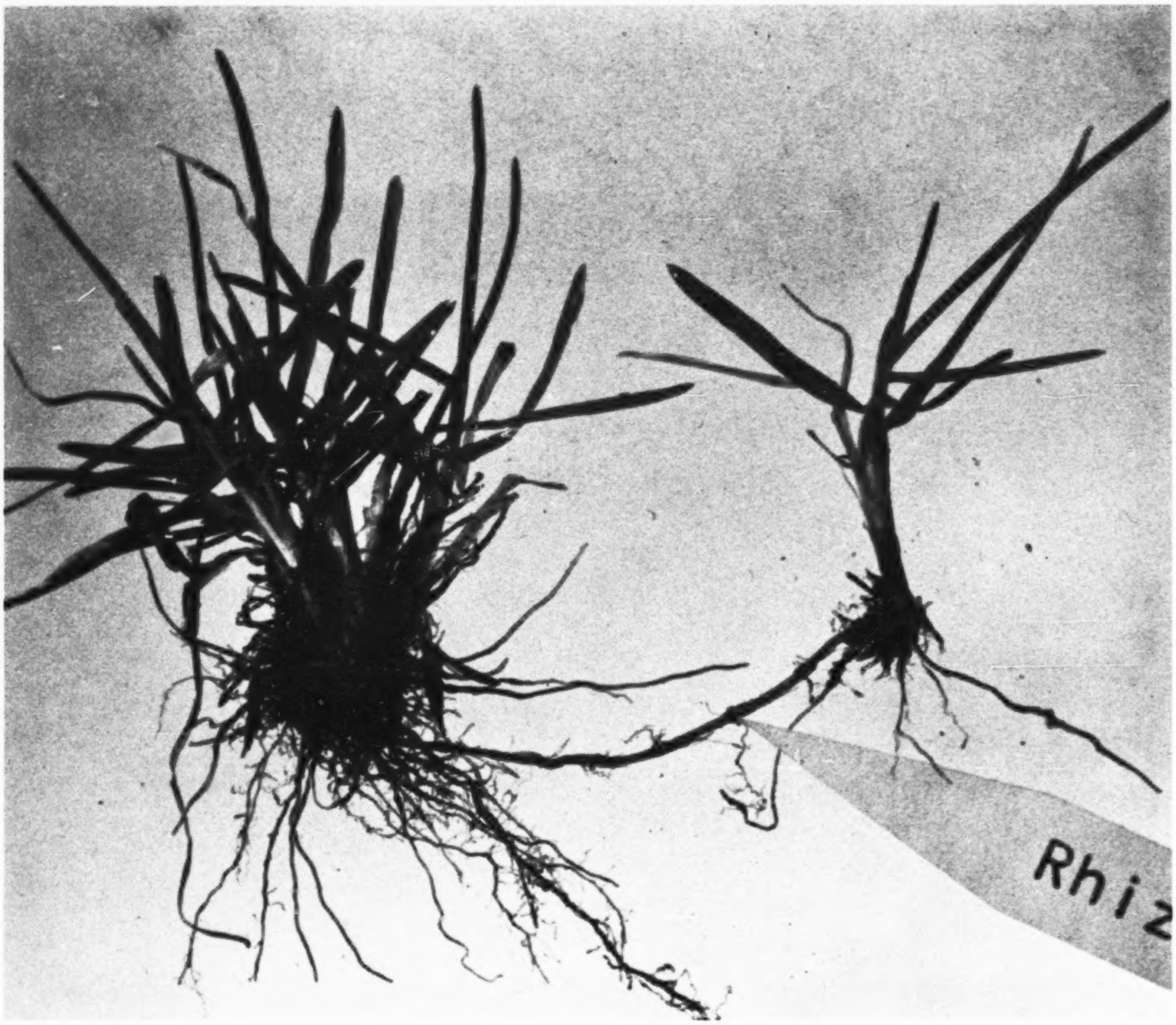
Crownvetch grows and persists over a wide range of soil types but will not tolerate poor drainage. It will, however, tolerate shade, drought, and cold. It may require two full growing seasons to become fully established. It does not require mowing. Crownvetch is established from both seed and plant crowns. The seed must be treated with a crownvetch innoculant (nitrogen forming bacteria) before planting to assure good growth.

Some of the more commonly used varieties of each of these grasses are pictured and described on the following pages.



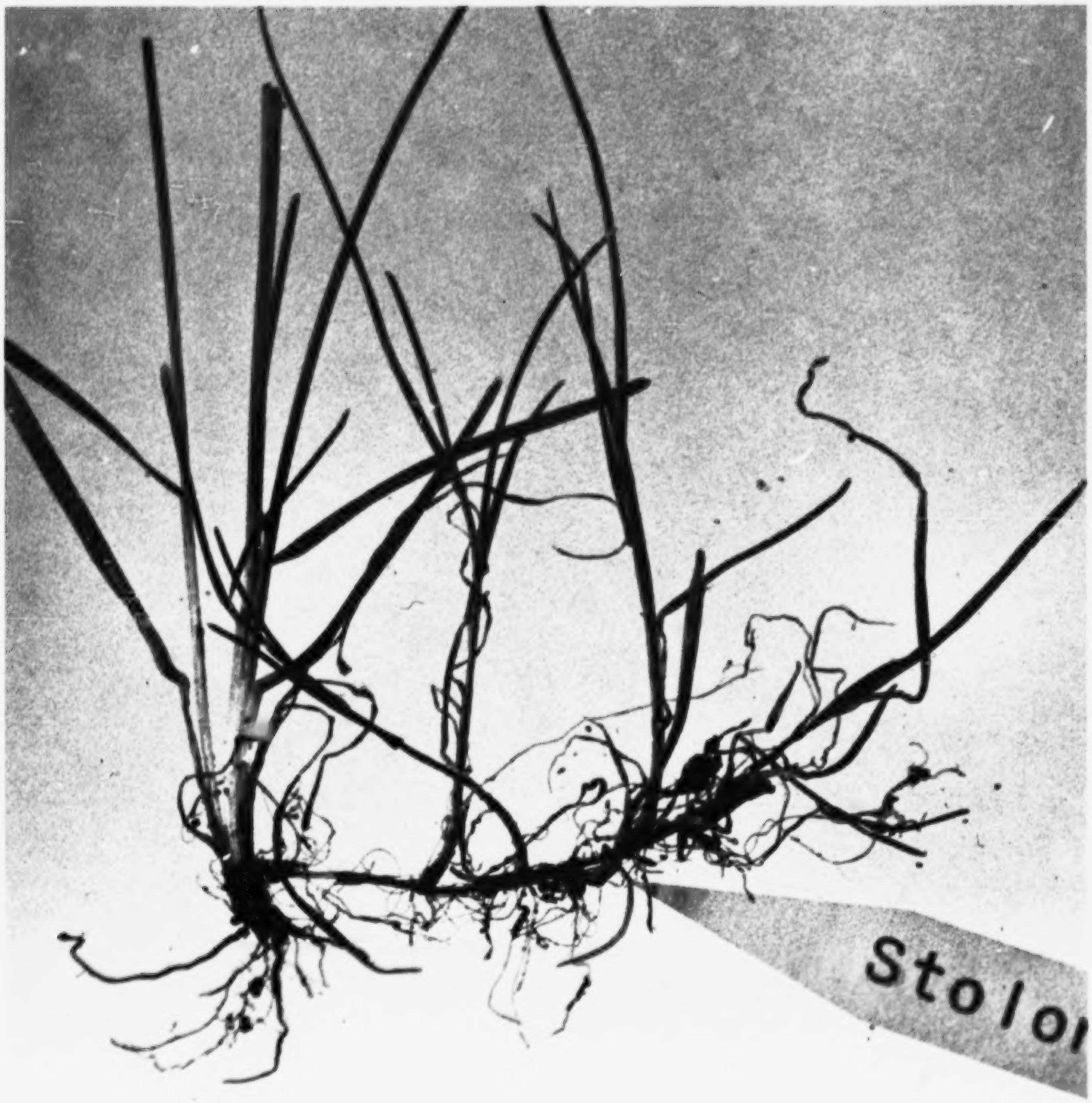
Kentucky Bluegrass (Poa pratensis)

Kentucky bluegrass, a perennial, may be planted alone or as part of a mixture in lawns, fairways, and athletic fields. It forms a turf of medium texture and density with a bright apple-green color. It has numerous spreading rhizomes. It grows best in sunny areas on fertile, properly limed (optimum pH 6.5 to 7.5), well-drained soils. Poor growth may result from poor soil drainage, low soil pH, low fertility, dense shade, close mowing (less than 1 1/2 inches), or frequent shallow waterings. Kentucky bluegrass has a high moisture requirement during its active growing period (spring and fall). It is semi-dormant during midsummer and is considered highly tolerant to drought. Kentucky bluegrass may be identified by the following vegetative characteristics: (1) top leaf rolled in the bud, (2) rhizomes, (3) leaf at 45-degree angle from stem, (4) ligule short and smooth, and (5) leaves similar to rough bluegrass but longer blade.



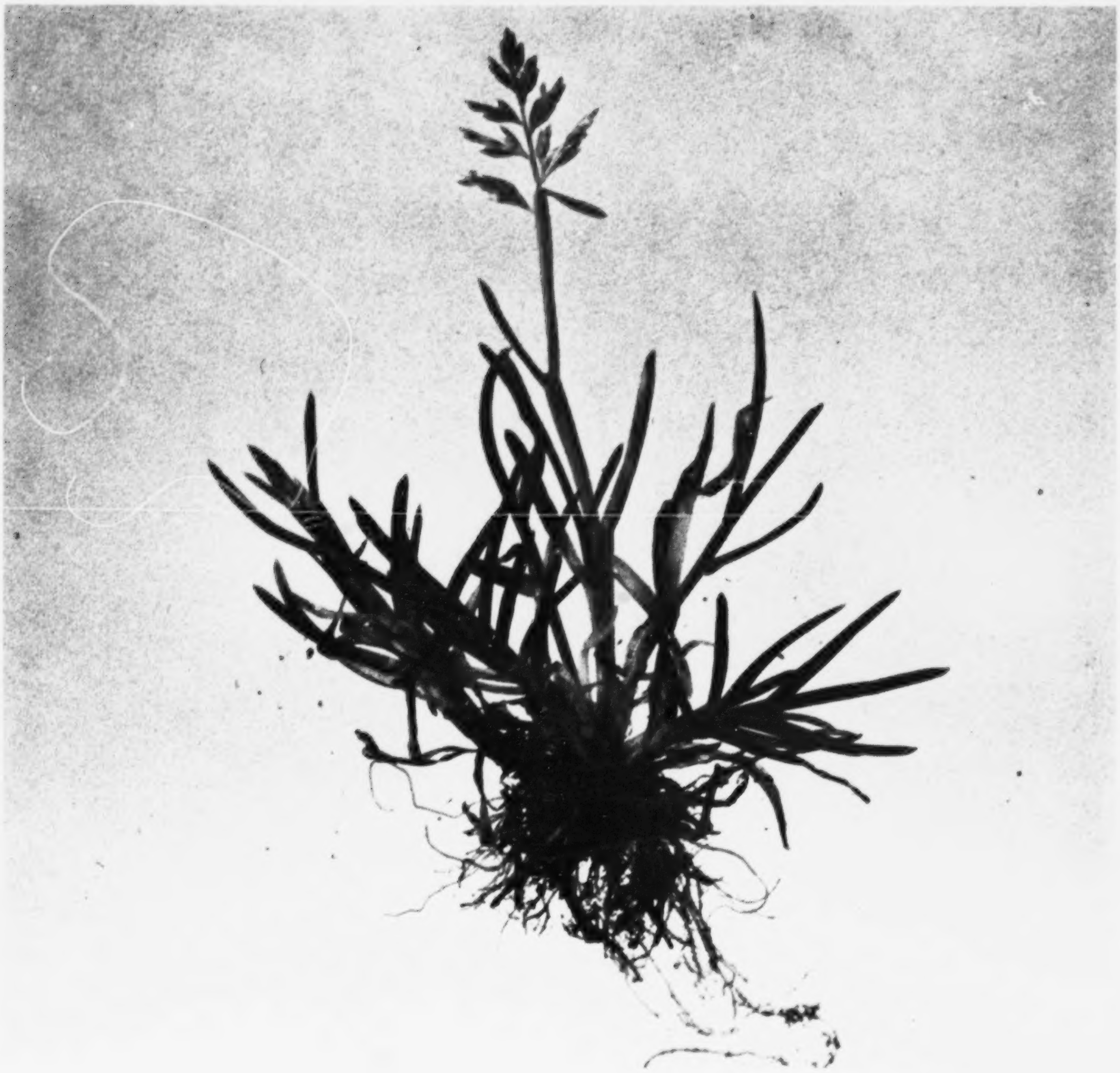
Merion Kentucky Bluegrass (Poa pratensis var. Merion)

Merion Kentucky bluegrass, a perennial, is a variety of Kentucky bluegrass. It forms a low-growing, dense, medium-textured turf. Under proper management it has certain advantages over other bluegrasses. It may be mowed as short as 1 to 1 1/4 inches and it can withstand dry conditions. However, it is more susceptible to rust, mildew, and leaf spot diseases, and requires heavier fertilization than other bluegrasses. It germinates more slowly than other bluegrasses, fescues, and bentgrasses. It will suffer from low fertility more than other bluegrasses. Merion Kentucky bluegrass can be distinguished from Kentucky bluegrass by the fact that its leaves grow at a 90 degree angle from the stem. The leaves of Merion are also stiffer.



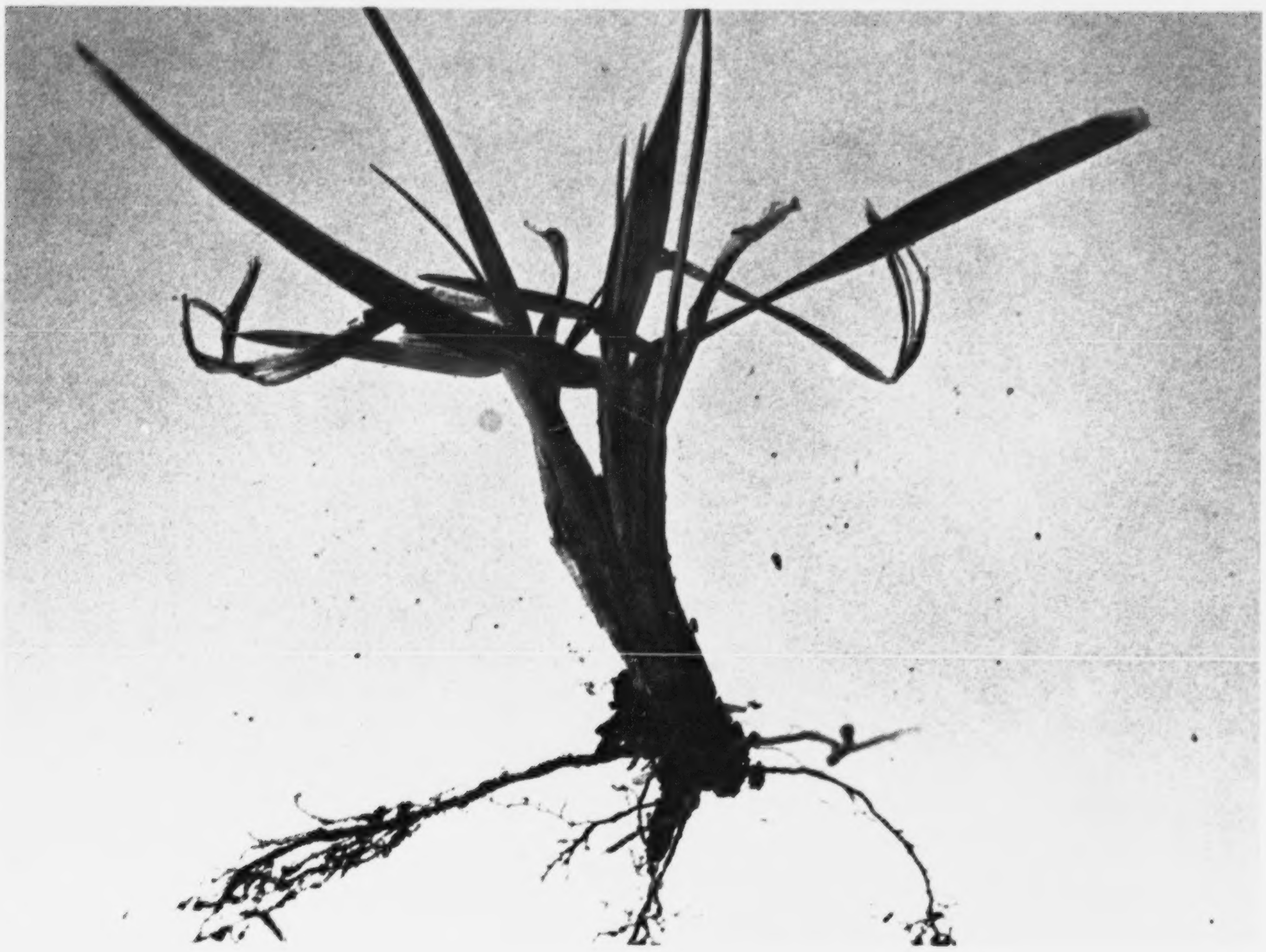
Rough Bluegrass (Poa trivialis)

Rough bluegrass is a perennial tolerant to shady areas. It is adapted to wet, poorly drained soils which are not excessively acid. It is long-lived and spreads by short stolons. It is a soft-textured grass with leaves and stems which lie relatively flat and which give the turf a smooth, glassy appearance. Because of its shallow root system, it requires frequent watering and will not withstand traffic. Leaves are tapered from the base to the tip.



Annual Bluegrass (Poa annua)

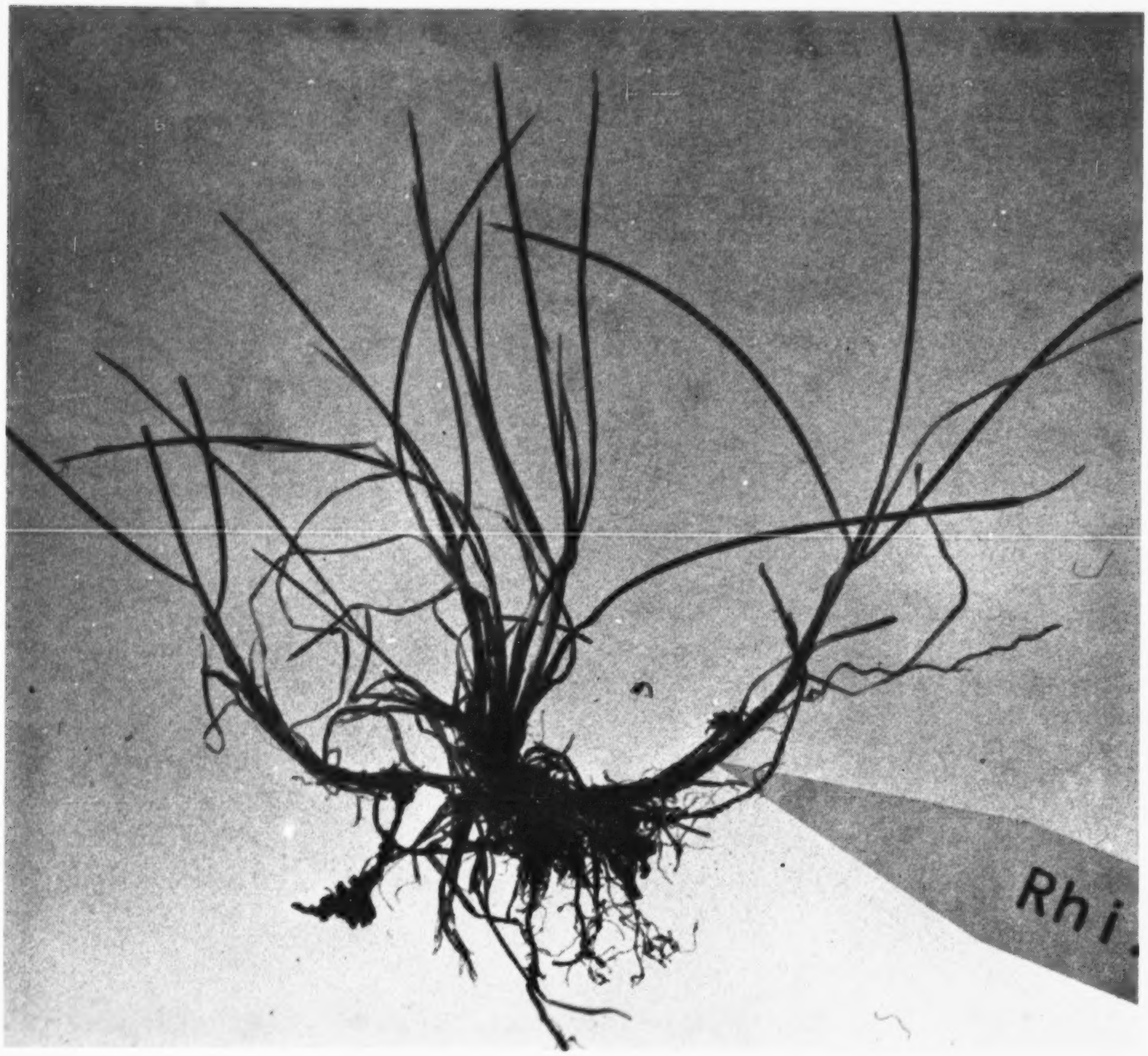
Annual bluegrass is usually considered a weed grass. It produces unsightly seed heads at any height of mowing. It may die during the summer, leaving brown patches in the remaining turf. Over-watering, mowing too short, and permitting the soil to become compacted are examples of conditions which favor the growth of annual bluegrass in place of the more desirable turfgrasses. Annual bluegrass may be identified from other bluegrasses by its green color, the presence of seed heads below normal mowing height, and by the lack of stolons or rhizomes. The ligule on annual bluegrass is long and prominent.



Tall Fescue (Festuca elatior)

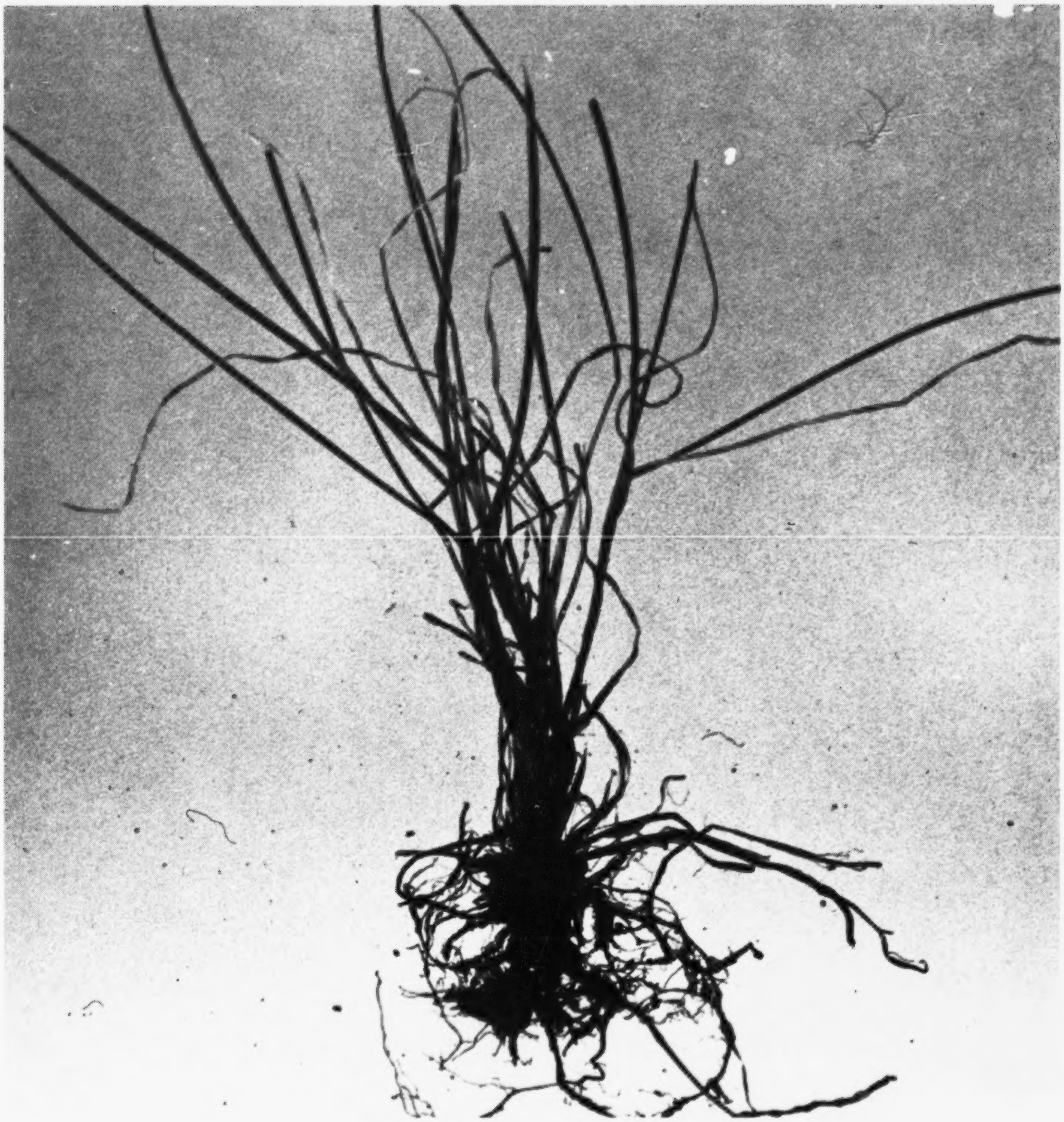
Tall fescue, sown in mixtures with other grasses, forms a heavy-duty turf suitable for playgrounds and athletic fields. It is adapted to a wide variety of growing conditions in the East and will tolerate dry soil. It is tolerant to sun, shade, and moderately acid soils. Heavy seeding rates help prevent tall fescue from growing in bunches. It is coarsely textured and has a strong fibrous root system. It is highly resistant to hard wear and will endure for a long time if it is not mowed to a height of less than 2 to 3 inches.

Tall fescue is rolled in the bud and has short auricles. The top-side of the leaf blade is a dull color with clearly visible leaf veins, and the underside is a shiny color. Tall fescue has reddish leaf sheaths below the ground and serrated leaf margins. The "Alta 31" strain is a particularly useful selection.



Creeping Red Fescue (Festuca rubra)

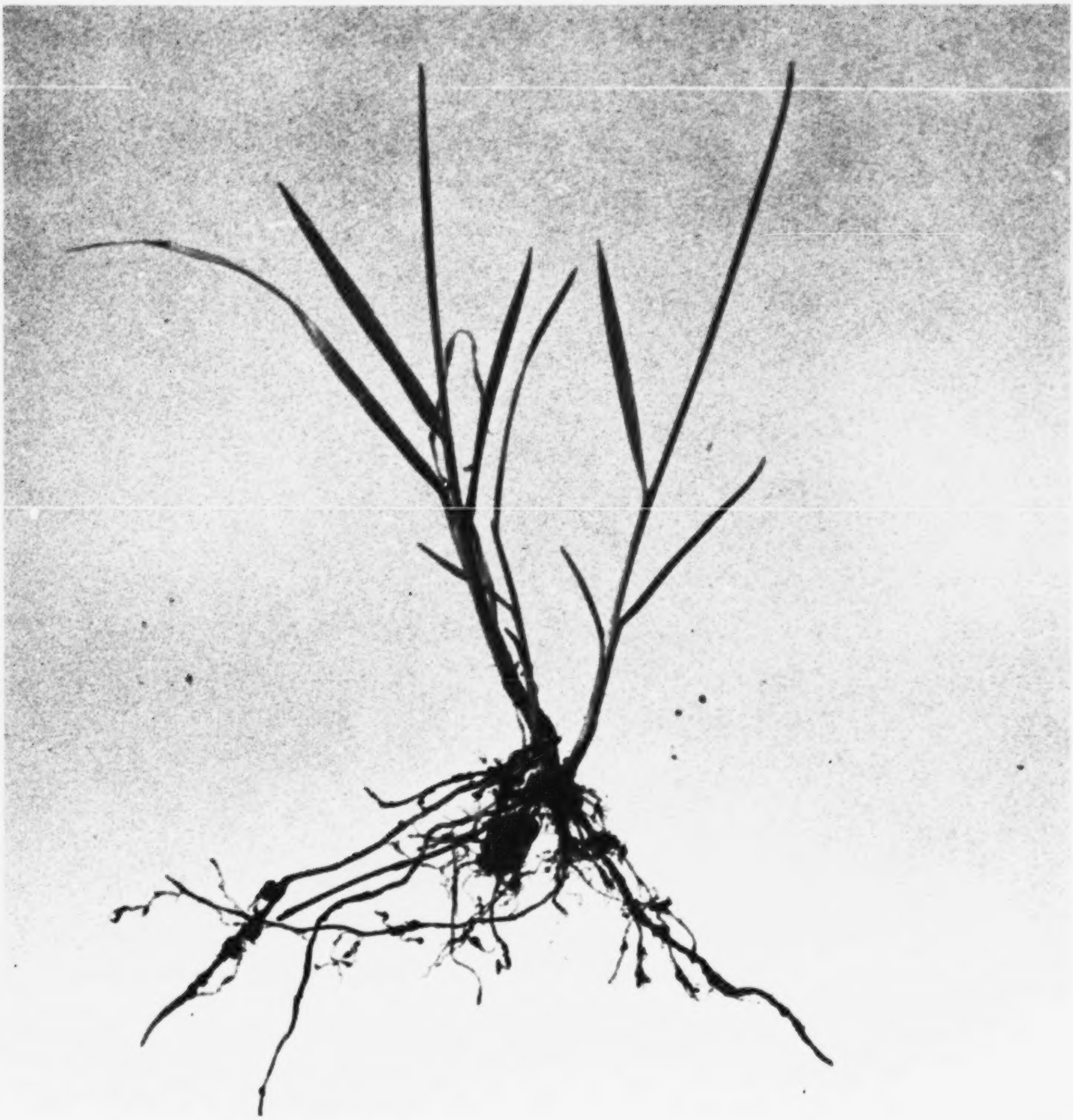
Creeping red fescue is often used with Kentucky bluegrass, because both require similar management. Also, creeping red fescue is shade tolerant, while Kentucky bluegrass is not. Creeping red fescue is a perennial with narrow, needle-like leaves. It will grow in droughty soils. It spreads by rhizomes, but is slow growing. Because of its slow growth, it is easily crowded out by other grasses if heavy fertilization, watering, and frequent clipping is practiced. It should not be clipped to heights of less than 1 1/2 inches. Creeping red fescue is folded in the bud and has rhizomes and a needle-like leaf. "Pennlawn" and "Illahee" are superior strains.



Chewings Fescue (Festuca rubra 'commutata')

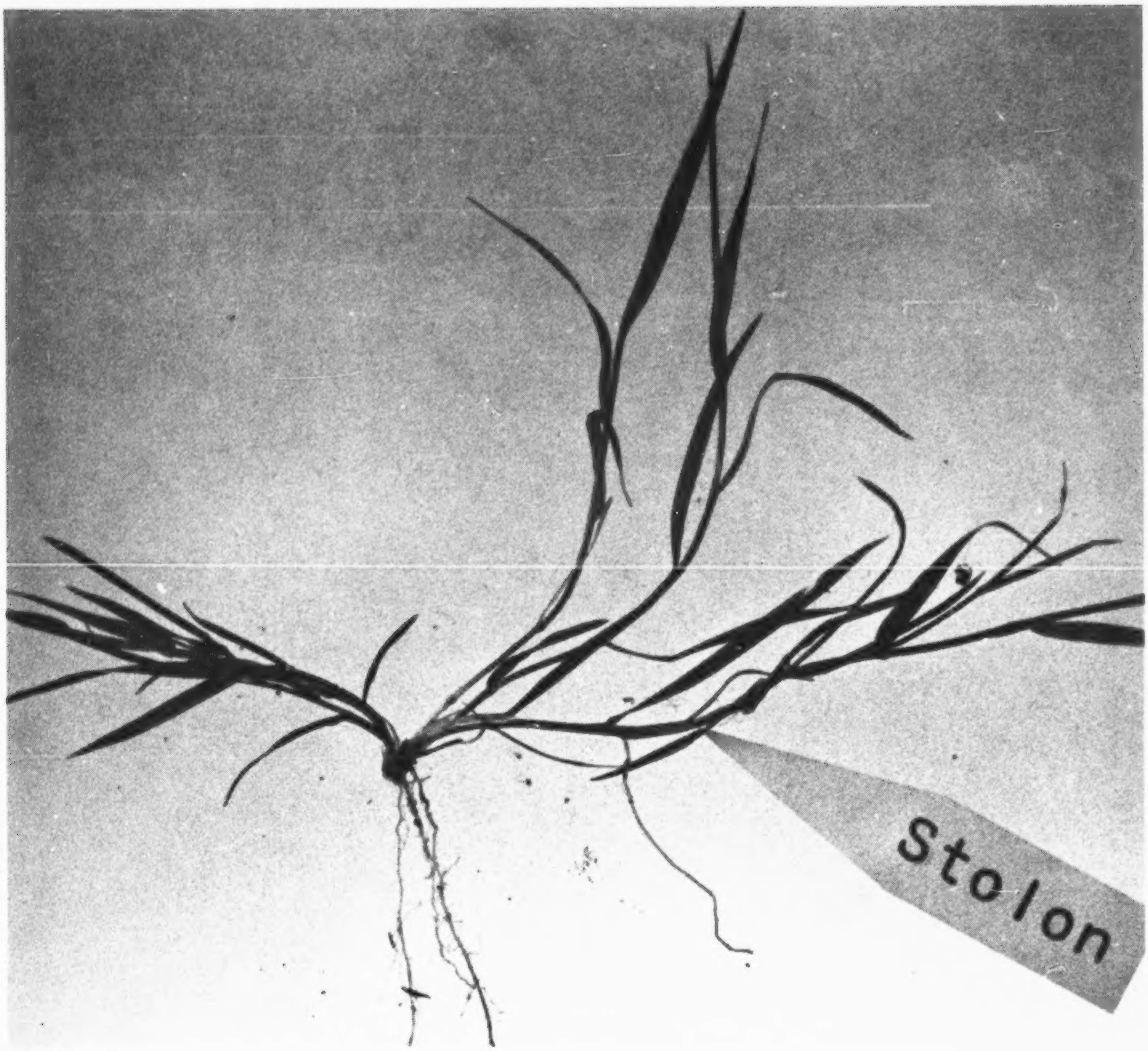
Chewings fescue is similar to creeping red fescue, but it is used less often because it does not mix well. It has a bunched rather than a creeping habit of growth. The management practices for creeping red fescue apply to Chewings fescue.

Chewings fescue may be identified by its needle-like leaf, bunched habit of growth, and absence of rhizomes.



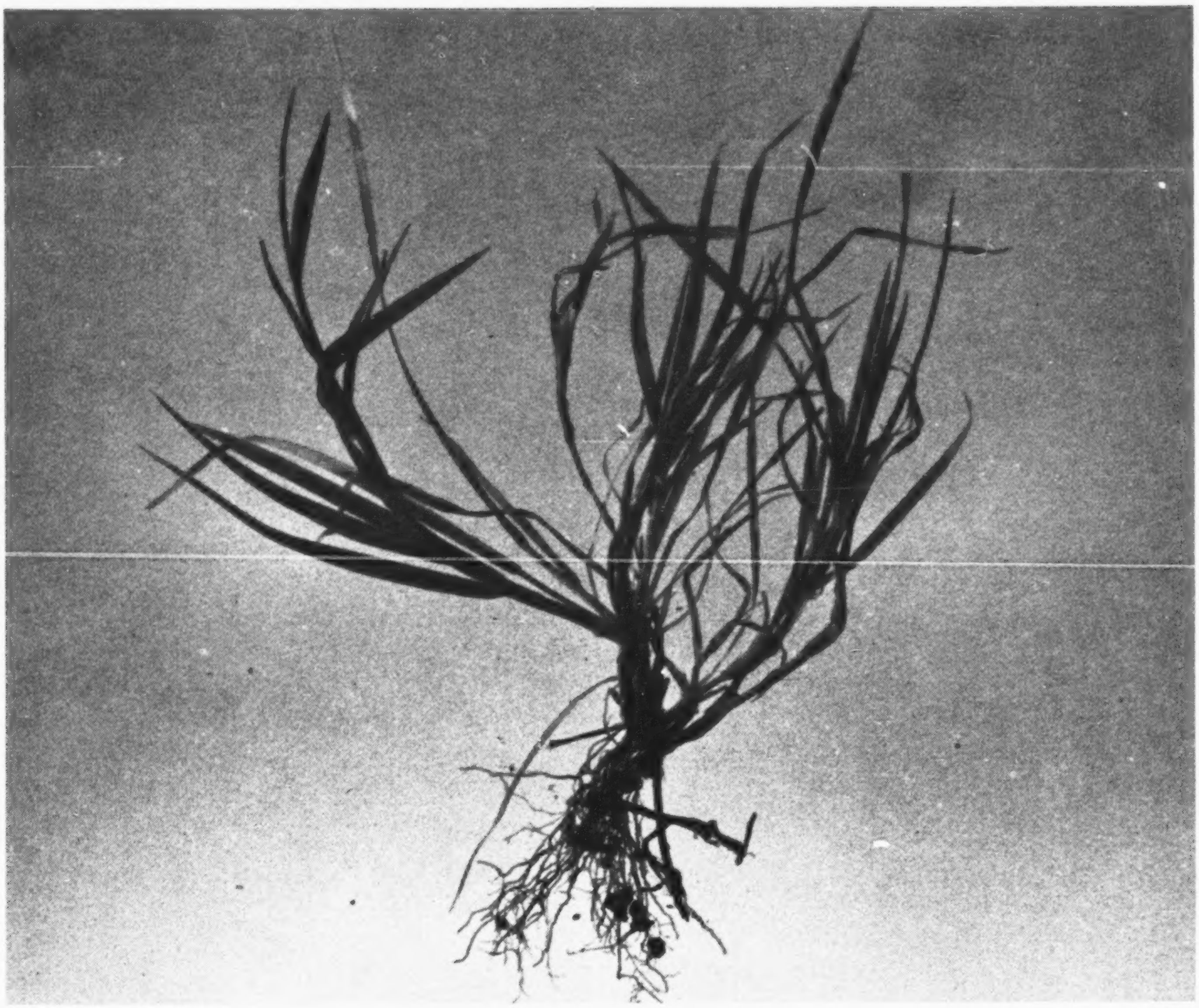
Colonial Bentgrass (Agrostis tenuis)

Colonial bentgrass is a perennial grass used primarily on tees and fairways. It may be mowed to a height of 3/8 to 3/4 of an inch. It produces a fine-textured, dense turf. It occasionally produces very short rhizomes and stolons. Although a few very short stolons may be present, colonial bentgrass may usually be identified from the other bentgrasses by the absence of stolons. "Astoria" is a good selection.



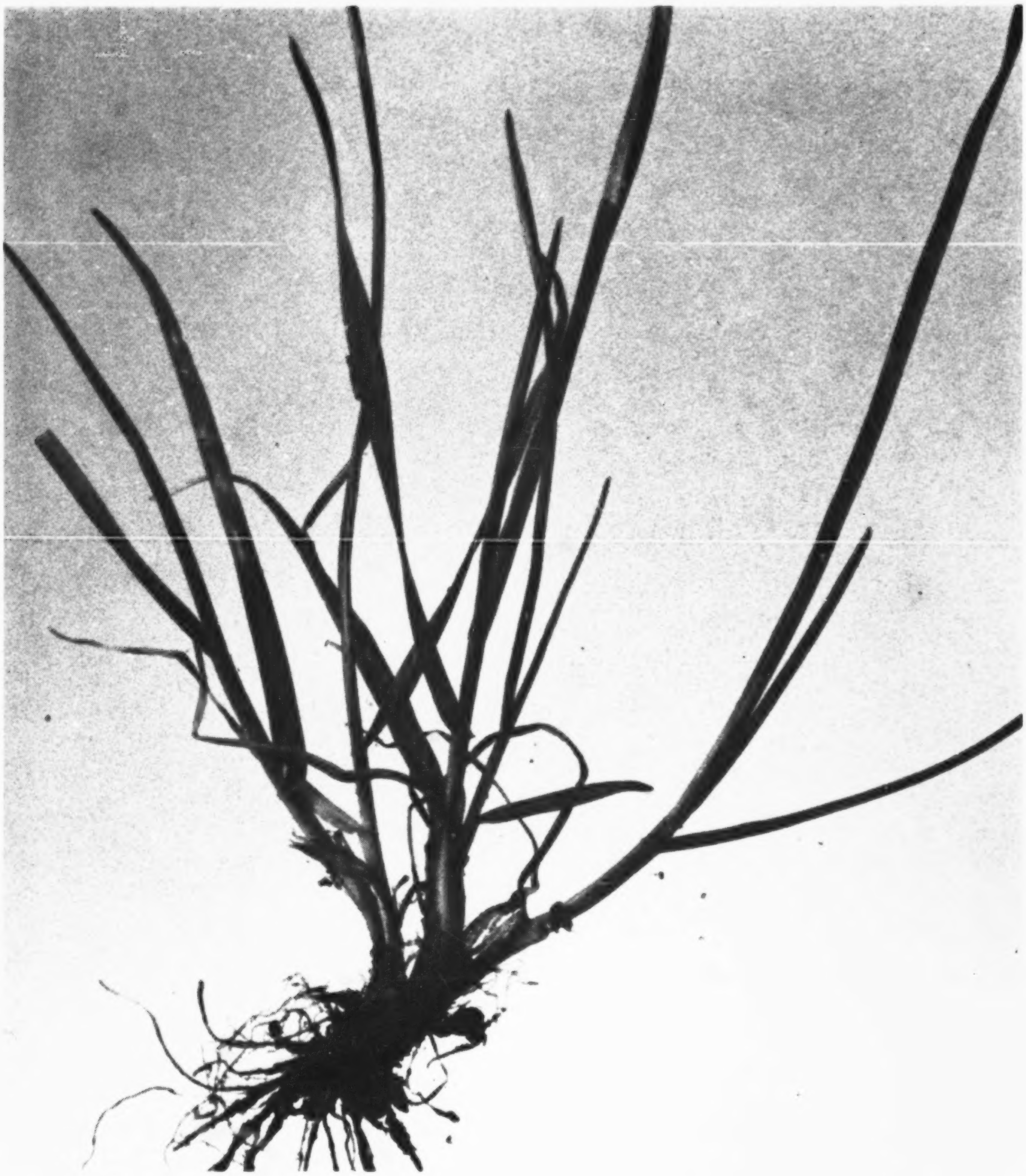
Creeping Bentgrass (Agrostis palustris)

Creeping bentgrass produces a dense, fine-textured sod with many creeping stolons which root and produce new plants. It is the best adapted and most widely used grass for golf course greens in the northern cool humid region. Because of its rapid growth rate, its moisture and fertility requirements are high. It produces the best turf where soil acidity is moderate to low and the fertility level, aeration, and water-holding capacity of the soil are good. It will, however, tolerate a wide variety of soil conditions. Two types of creeping bentgrass are propagated from seed - Seaside and Penncross. Some strains are propagated by planting short pieces of stolons. This is called "sprigging". Creeping bentgrasses have short parchment-like ligules.



Redtop (Agrostis alba)

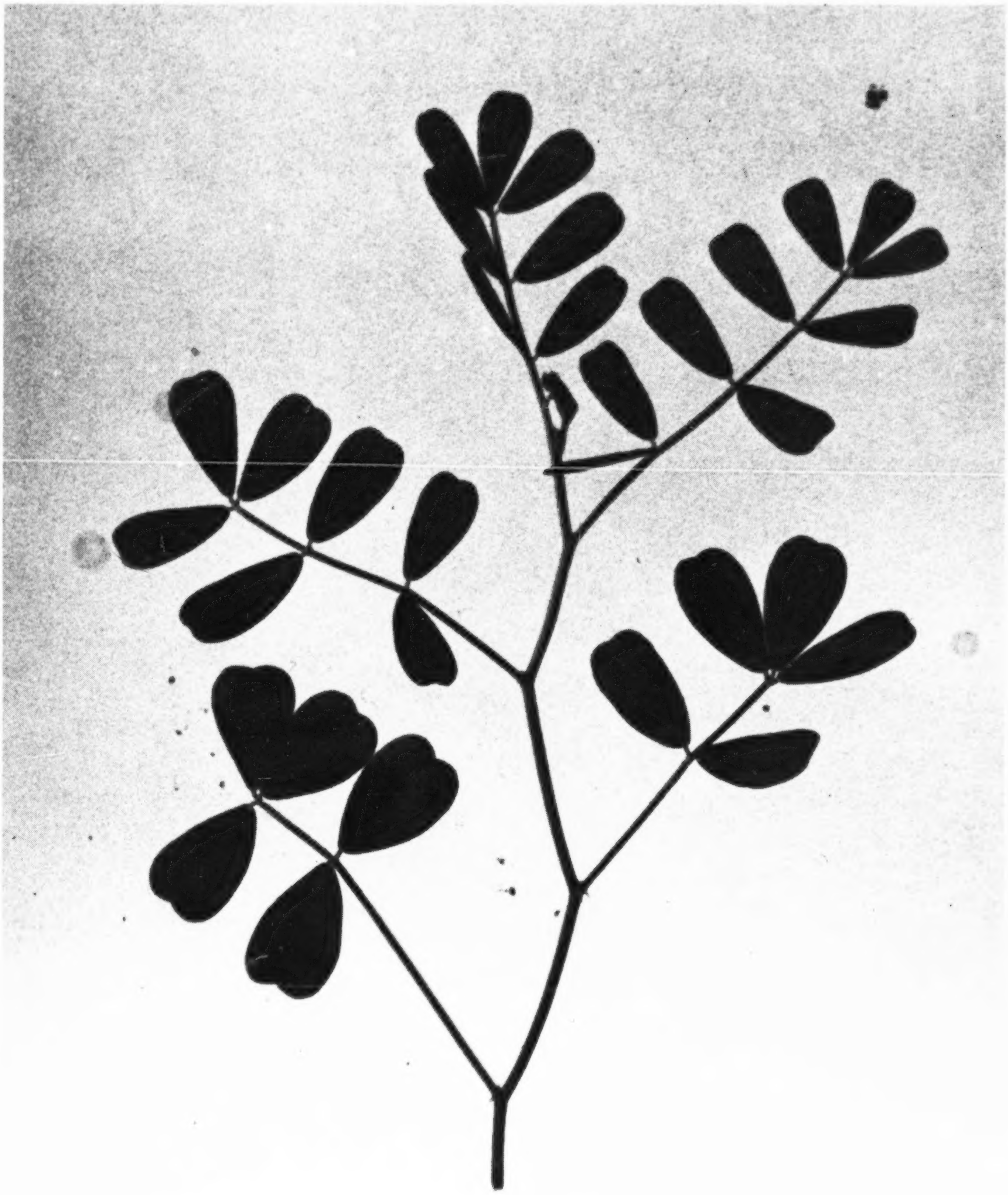
Redtop is a perennial grass used chiefly for the quick establishment of a temporary turf. It persists for only 2 or 3 years under usual turf management. Not over 3 percent Redtop should be included in grass mixtures. Redtop provides a quick groundcover and prevents weed invasion while the permanent grasses are becoming established. Redtop is adapted to a wide range of soil and climatic conditions. It is not only highly drought resistant, but also grows well on wet, poorly drained soils. It does not require high soil fertility for good growth. It will survive extremely acid conditions. Redtop is highly tolerant to temperature extremes and can be seeded either late in the fall or during mid-summer if sufficient moisture is available for germination. The following characteristics help distinguish redtop: (1) ligules, (2) rolled in the bud, and (3) absence of stolons and auricles.



Ryegrasses (Lolium species)

Italian ryegrass and perennial ryegrass are similar in appearance. However, Italian ryegrass is rolled in the bud, has auricles and smooth ligules, and does not have stolons. Perennial ryegrass is folded in the bud and has auricles.

Domestic ryegrass is sometimes used as a "green manure" crop for soil improvement.



Crownvetch (Coronilla varia L.)

Crownvetch can be identified by the following characteristics: (1) the stems have branches with 6 to 13 leaflets per branch, (2) leaflets are smooth, clover-like, and oppositely paired along the petiole, and (3) stems grow from a central crown to form a cluster and have a creeping habit of growth.

Test

1. What are the distinguishing growth characteristics of the more common species of turfgrasses?
2. List occupations for which the subject matter of this unit would be helpful.
3. Draw and label the parts of a grass.
4. Draw and label three types of:
    a. auricles
    b. leaf tips
    c. ligules
5. Give the identifying characteristics of:
    a. Kentucky Bluegrass
    b. Tall Fescue
    c. Creeping Bentgrass
    d. Creeping Red Fescue
    e. Colonial Bentgrass
    f. Crownvetch
6. Which grasses are often combined for playing fields?
7. Which grasses are usually used for putting greens or golf courses?
8. Which grasses are sometimes used to provide a temporary groundcover while slower growing, more permanent grasses are becoming established?
9. Name a legume often used for covering steep slopes where grasses would not be satisfactory.
10. What turfgrasses are commonly used along highways?

SUGGESTIONS AND REFERENCES FOR THE TEACHER

The estimated investment in turf in the United States is eight billion dollars per year. This figure includes money spent on home lawns, golf courses, athletic fields, highway turfs, and other special turf areas. Employment opportunities are growing, especially in areas near cities with populations of 25,000 or more. Employers want skilled and semi-skilled workers who know about the special uses of turf and about their care and maintenance. Much of the work for semi-skilled workers is seasonal. The beginning point in the development of the desired knowledge and skills is the identification of turfgrasses.

Learning Resources

References:

Turf Management, pp. 84-117, Reference No. 25.

Turfgrass Guide, pp. 1-4, Reference No. 27.

Supplies:

Dried and mounted grass specimens.

Live, potted turfgrasses when feasible.

Audio Visual Aids:

"Turfgrass Identification" a series of color slides. Shelly, Christopher H., Department of Agricultural Education, The Pennsylvania State University, University Park, Pennsylvania, 16802.

"Types of Turf" a series of color slides. Shelly, Christopher H., Department of Agricultural Education, The Pennsylvania State University, University Park, Pennsylvania, 16802.

Suggested Student Learning Activities

1. Have the students study Problem Area 2.
2. Show and have students study the slide series "Turfgrass Identification" and the series "Types of Turf."
3. Have students prepare mounts of different species of turfgrasses.
4. Arrange a field trip to reinforce the student's knowledge of turfgrasses. See the Turf Field Trip Observation Record on the following pages.

Turf Field Trip
Observation Record

Name ____

Date ________________ Location ____________________________

1. Type of turf area visited (check):

Home lawn ____

Athletic field ____

Highway turf ____

Park ____

Golf green ____

Golf tee ____

Golf fairway ____

Other (specify) ____________

2. Soil and site characteristics:

Soil type ____________________

Drainage:

Well drained ____

Moderately drained ____

Poorly drained ____

pH ____

Slope ____

Exposure to sun:

Open sun ____

Partial shade ____

Shade ____

Traffic:

Heavy ____

Moderate ____

Light ____

3. Turf characteristics:

Grass mixture ________________

Turf coverage:

Dense ____

Moderate ____

Thin ____

Describe the growth conditions of the grass:

Problem areas: (Thatch, grain, etc.)

4. Evidence of Pests:

Weeds:	Diseases:	Insects:

5. Management Practices:

Height of cut ________________

Turf edged ________________

Sprays applied (rate, date, etc.):

____

____

____

____

____

6. Fertility practices:

Fertilizer applied (analysis, rate, date, and method of application):

Lime applied (type, rate, date, and method of application):

7. Irrigation practices:

8. Top-dressing (for golf courses):

9. Notes:

PROBLEM AREA 3

MAINTAINING RESIDENTIAL AND INSTITUTIONAL LAWNS

Student Learning Objectives

1. To learn how to maintain good soil fertility for residential and institutional lawns.
2. To learn the appropriate mowing practices for lawns.
3. To learn how to water a lawn properly.
4. To learn how to identify and control lawn pests.

Key Questions

1. What are the major problems involved in maintaining residential and institutional lawns?
2. What are the major problems or skills needed in maintaining soil fertility? Mowing a lawn? Watering the lawn? Controlling lawn pests?

New Words

Aeration - providing air
Agronomist - a soil scientist
Auger - a tube or cork-screw type tool for taking soil samples
Dormant - in a non-growing condition
"Grain" - streaked appearance of turf due to uncut tufts of grass
Granular - having small particles
Microorganisms - animals and plants smaller than visible size
Nutrient - a chemical required by a plant
Soil structure - arrangement of soil particles
Soil texture - soil particle size (clay has "fine" texture - sand has "coarse" texture)
Synthetic - made by man
Thatch - accumulation of dead leaves at soil surface in turf
Tolerant - able to withstand an adverse condition
Vertical mowing - cutting with knives that cut through thatch

Maintaining Residential and Institutional Lawns

If turf fails to continue to be beautiful and serviceable, poor maintenance is the cause. This problem area is devoted to a review of good lawn maintenance practices. These include maintaining adequate soil fertility, proper mowing, watering properly, and controlling lawn pests.

Figure 1. Many properly established home lawns become unsightly because of poor maintenance. The lawn pictured above will maintain its beauty if properly fertilized, mowed, watered, and kept free of diseases, insects, and weeds.

Maintaining Soil Fertility

Taking a Soil Sample

A soil test, made in early spring, is the only sure way to determine the fertility needs of a lawn turf. General fertility recommendations may be made, but they are guesses unless they are based on a soil test. If the soil is varied, separate samples should be collected from each different area. About one pint of soil is needed for each soil test. A number of tools are available for correct sampling of soils: the soil auger, trowel, small spade, or a pipe sampler with a cut-away section.

Soil samples should be taken to a depth of approximately 2 to 3 inches. Within this depth lies the zone of maximum root growth and activity. Enough sub-samples should be taken to make the soil representative of the entire turf area. Areas along the edge of roads, under the eaves of a building, or on steep slopes should be avoided.

Sub-samples should be mixed in a pail before the soil test container is filled. The soil should be placed in the test kit container and properly labeled. The soil should be mixed and handled with a large clean spoon or similar tool. Instructions for taking soil samples for turf are given on page 42.

The information requested on the soil test forms is important for proper analysis of the soil. An example of this form is printed on page 41. Be certain to complete such a form when sending a soil sample so that the agronomist can give appropriate recommendations.

There are a number of laboratories at which soil may be tested. Ask your teacher for the address of the nearest soil-testing laboratory. Usually, the state university is a good place to get the soil sample tested. Most soil tests cost from one to two dollars per sample.

Interpreting Soil Test Recommendations

Fertilizer and lime recommendations for lawns are based on the results of the soil test. If the soil was sampled properly, the recommendation may be followed with confidence. Fertilizer recommendations for lawns usually specify that a given amount of a particular grade of fertilizer by used. The amount of fertilizer to apply per 1,000 square feet of turf area will vary, depending on the lawn being sampled. The grade of fertilizer usually recommended is either a 10-5-5 or a 12-6-6. The first figure stands for the percent of available nitrogen (N), the second for percent of available phosphates (P_2O_5), and the third for percent of water soluble potash (K_2O). Note that both grades have a 2:1:1 ratio. Other fertilizer grades with similar analysis may be used satisfactorily.

Examine the soil test information forms on the following pages.

Lime Requirements

Lime, or calcium carbonate, is often needed in addition to nitrogen, phosphorus and potash. It may be used to make the soil less acid, thus making fertilizer nutrients more available to plants. It may further improve the soil by causing a more open soil structure.

The pH refers to the acidity or alkalinity (hydrogen ion concentration) of the soil. Soil pH is also refered to as "soil reaction." A pH of 7.0 is neutral. A pH above this point is alkaline. A pH below this point is acid.

THE PENNSYLVANIA STATE UNIVERSITY
SOIL TESTING LABORATORY, COLLEGE OF AGRICULTURE
UNIVERSITY PARK, PENNSYLVANIA 16802

LABORATORY NO. ______
SERIAL NO. ______
MO. DAY YEAR

NAME ______
STREET OR R.D. NO. CITY AND ZIP NO. ______
COUNTY

NAME OF COMMERCIAL FIRM ______
STREET ______
CITY AND ZIP NO.

TURF INFORMATION SHEET

SAMPLE IDENTIFICATION ☐☐☐

RECOMMENDATION WANTED (ONLY CHECK ONE)

FOR ESTABLISHMENT ☐
INDICATE MONTH TO BE SEEDED ______
FOR MAINTENANCE ☐

IF ESTABLISHMENT WAS CHECKED NO ADDITIONAL INFORMATION NEEDED.
IF MAINTENANCE WAS CHECKED YOU MUST COMPLETE THIS FORM.

AREA IS: (ONLY CHECK ONE)

- ☐ (1) LAWN
- ☐ (2) PARK
- ☐ (3) CEMETERY
- ☐ (4) ATHLETIC FIELD PLAY AREA
- ☐ (5) SCHOOL LAWN
- ☐ (6) GREEN
- ☐ (7) TEE
- ☐ (8) FAIRWAY
- ☐ (9) ROUGH
- ☐ (10) ROADSIDE

GRASS SPECIES PRESENT (CHECK)

- ☐ (1) MERION BLUEGRASS
- ☐ (2) OTHER KENTUCKY BLUEGRASS VARIETIES
- ☐ (3) BENTGRASS
- ☐ (4) RED FESCUE
- ☐ (5) TALL FESCUE
- ☐ (6) ZOYSIA
- ☐ (7) BERMUDA
- ☐ (8) ANNUAL BLUEGRASS (POA ANNUA)

HEIGHT MOWER IS SET TO CUT IS:

- ☐ (1) LESS THAN 1 ½ INCHES
- ☐ (2) 1 ½ INCHES OR HIGHER

INDICATE SPECIAL PROBLEMS BY CHECKING BELOW

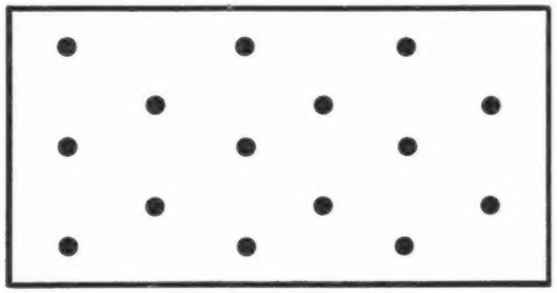
- ☐ (1) CRABGRASS
- ☐ (2) OTHER WEEDS
- ☐ (3) MOWING
- ☐ (4) IRRIGATION
- ☐ (5) THATCH
- ☐ (6) DISEASE
- ☐ (7) INSECTS
- ☐ (8) SHADE
- ☐ (9) SOIL COMPACTION
- ☐ (10) MOSS AND ALGAE
- ☐ (11) FERTILIZATION
- ☐ (12) LIMING
- ☐ (13) EROSION

Send this copy to laboratory with sample - your report cannot be completed without it.

SOIL SAMPLING INSTRUCTIONS
for
TURF SOILS

A SOIL TEST IS NO BETTER THAN THE SOIL SAMPLE SUBMITTED FOR ANALYSIS. SAMPLES SHOULD BE TAKEN AS FOLLOWS:

1. Using a soil sampling tube, auger or trowel, and a clean pail, obtain thin slices or borings of soil from 12 or more locations. Follow the diagram below to properly locate the samples. Sample to a depth of 2 to 3 inches.



2. If the area varies in kind of soil, previous fertilizer or lime treatments, use separate test kits for each different area.
3. Discard all grass and accumulated thatch material. Do not contaminate soil with cigarette, cigar or pipe ashes, fertilizer or other materials.
4. Mix the soil taken into one composite sample. Spread soil on newspaper in a warm room to air dry overnight. Do not heat.
5. Take a ½ pint representative sample and place in the official container supplied with this information sheet.
6. Fill in the information requested on opposite side of this form and mail the original in the envelope attached to the sample bag. Keep the yellow copy for your files.
7. Before mailing, check the serial number on this form against the serial number on the envelope, they should be the same.
8. If you have a situation where a maintenance recommendation for an existing turf area is desired and also a recommendation for establishing a new turf area is desired you must use separate soil test kits for each area.

7-24-68	1234	17850	Centre	1	Lawn
DATE	LAB NO.	SERIAL NO.	COUNTY	FIELD	SOIL

THE PENNSYLVANIA STATE UNIVERSITY
SOIL & FORAGE TESTING LABORATORY
COLLEGE OF AGRICULTURE
UNIVERSITY PARK, PENNSYLVANIA 16802

- SOIL TEST REPORT FOR:

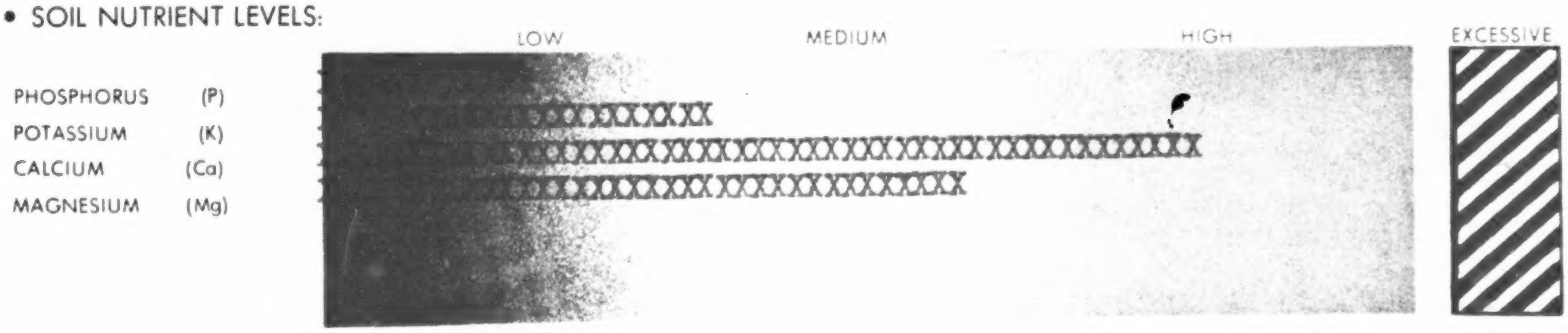
Mr. Philip Doe
Anytown
U. S. A.

- LABORATORY RESULTS:

6.4	6.7	84	0.28	1.7	11.5	16.5	1.7	10.2	69.9
pH SOIL	pH BUFFER	P (lbs/A)	K	Mg	Ca	CEC	K	Mg	Ca
				(me per 100 gm.)				% Saturation	

OTHER:

- SOIL NUTRIENT LEVELS:



- LIMESTONE AND FERTILIZER RECOMMENDATIONS FOR Maintenance of Turfgrass -

Apply 75 lbs. of ground agricultural limestone per 1000 sq. ft. Apply in fall, winter or early spring.
Apply in the spring and in the fall annually -
25 to 30 lbs. per 1000 sq. ft. of a 10-5-5, 10-6-4, 12-6-6 or similar fertilizer which contains 35 per cent or more of the total nitrogen as water insoluble nitrogen natural organic materials or ureaform compound.
Apply 10 lbs. of an 0-20-20 fertilizer per 1000 sq. ft. in the fall each year for 3-4 years.

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A pH range of 6.5 to 7.5 is considered best for most lawns of Merion Kentucky bluegrass, common Kentucky bluegrass, or creeping red fescue. If the pH drops below 6.5, lime should be added to correct soil acidity. Enough lime should be added to raise the pH to 6.5 or 7.0. By raising the pH, the nitrogen, phosphoric acid, and available potash supplied in a complete fertilizer are more readily available to the grass plants.

General Lawn Fertility Recommendations

The general recommendation for residential lawns, and all other turf which contains a mixture of Kentucky bluegrass and creeping red fescue, is that it should receive about 32 lb. of a 20-6-4, or similar analysis, fertilizer per 1000 sq.ft. per year. This is usually applied in 4 applications per year. The nitrogen in this fertilizer should be ureaformaldehyde with a slow release of at least 50%. This fertilizer should be applied according to the following program.

Application of 20-6-4 (ureaformaldehyde N) to Kentucky bluegrass-Creeping red fescue turf.

Date	Rate
April 1 (April Fool's Day)	8 lb. per 1000 sq.ft.
July 4 (Independence Day)	8 lb. per 1000 sq.ft.
Early September (Labor Day)	8 lb. per 1000 sq.ft.
On light snow (Christmas Day?)	8 lb. per 1000 sq.ft.

Merion Kentucky bluegrass requires more nitrogen than other grasses. In a turf of Merion Kentucky bluegrass the following additional applications of fertilizer should be made.

Additional applications of ammonium sulfate for Merion Kentucky Bluegrass turf.

Date	Rate
May 1	1 lb. per 1000 sq.ft.
June 1	1 lb. per 1000 sq.ft.
August 1	1 lb. per 1000 sq.ft.

Some greenskeepers have reported that a tougher, more disease-resistant turf seems to develop when one application of an 0-20-20 fertilizer at 5 lb. per 1000 sq.ft. is made in late October. This is in addition to the regular fertilizer program given above.

Some greenskeepers make a light application of limestone (5 lb. per 1000 sq.ft.) each spring as a precautionary measure to aid in preventing a buildup of thatch. This is discussed in greater detail on page 51. If a soil test indicates that the soil is too acid, the amount of limestone in this application is increased.

Selecting and Purchasing Fertilizers

Fertilizer materials are sold in pulverized (dust or powder) and granular forms. Pulverized fertilizer is more difficult to spread, especially when the weather is wet or windy. Granular fertilizers have an advantage over pulverized forms, because they are not affected by winds, do not clog fertilizer spreaders, and do not stick to wet grass leaves. However, they cost more per pound of total available nutrients than the pulverized forms.

Not all fertilizers are the same. Fertilizers may differ in two ways. First, they may contain different percentages of nutrients by weight. Secondly, they may differ in the rate at which their nutrients, especially nitrogen, become available to the turfgrass. Fertilizers should be purchased on the basis of the cost per unit weight of available nutrients and not according to total weight.

Maintenance applications of fertilizer should be based on the type of nitrogen in the fertilizer. Nitrogen may be either quickly or slowly available. Quickly available nitrogen fertilizers include such materials as ammonium sulfate, ammonium nitrate, and urea. The nitrogen in these fertilizers is water soluble and thus becomes quickly available when the soil is not frozen. Quickly available forms of nitrogen result in rapid growth of dark green grass. Frequent, light applications of these materials are necessary to obtain relatively uniform growth over a period of time. To prevent grass "burn," an application of these compounds should not exceed 1½ pounds of actual nitrogen per 1000 square feet of turf area.

Slowly available nitrogen fertilizers release their nitrogen over a longer period of time. The speed of availability of the nitrogen to the turfgrass depends on the activity of soil microorganisms which transform the compounds into an available form of nitrogen. Soil temperatures of 60° F or higher activate these microorganisms. Because soil temperatures are low in winter and early spring, these fertilizers are less effective than others applied at those times.

Slowly available nitrogen fertilizers may be divided into two categories: natural organic fertilizers and ureaform (ureaformaldehyde) compounds. Processed sludge, animal and vegetable tankage, and seedmeals are natural organic fertilizers. The rate of break-down and the rate of availability varies with the chemical composition of the fertilizer.

Ureaform compounds are synthetic compounds which act like organic materials. The soil microorganisms break down these compounds in stages. As one portion of the compound is decomposed, another becomes exposed for decomposition. This procedure progresses until the compound is completely broken down. The ureaforms release small amounts of nitrogen continuously over a relatively long period of time. For this reason, they may be applied less frequently than the quickly available forms of nitrogen.

Phosphorus is primarily available to the turfgrasses as phosphoric acid. Phosphoric acid may be supplied in several forms such as organic materials, superphosphates, and ammonium phosphates. Both the organic materials and the superphosphates must be transformed in the soil before they become available to the turfgrasses. They are slowly available. Ammonium phosphate supplies phosphoric acid which is water soluble and which is quickly available. It is a highly concentrated fertilizer and should be applied with extreme caution to prevent severe injury to the turf.

The availability of phosphorus depends on soil acidity, soil texture, and soil content of organic matter. Under improper soil conditions, phosphoric acid may be changed to insoluble or unavailable forms. Phosphorus deficiencies may appear, and with them poor soil conditions, even though sufficient quantities of phosphorus have been applied.

Most of the forms of potash supplied in fertilizers are water soluble and thus quickly available. Heavy soils usually need less potash than sandy soils. Potash is rapidly leached from sandy soils.

Applying Fertilizers and Lime

Fertilizers should be spread mechanically. Spreading by hand may result in uneven application and fertilizer burn. There are a number of reliable mechanical spreaders on the market. The two basic types are the broadcast spreader and the seeder (or hopper) spreader.

The broadcast-type spreader distributes the fertilizer from a drum in a circular pattern. It is less accurate, but applies fertilizers much faster than the seeder spreader. It makes a pattern about 8 feet wide. Fertilizer spread with a broadcast spreader in windy weather may drift.

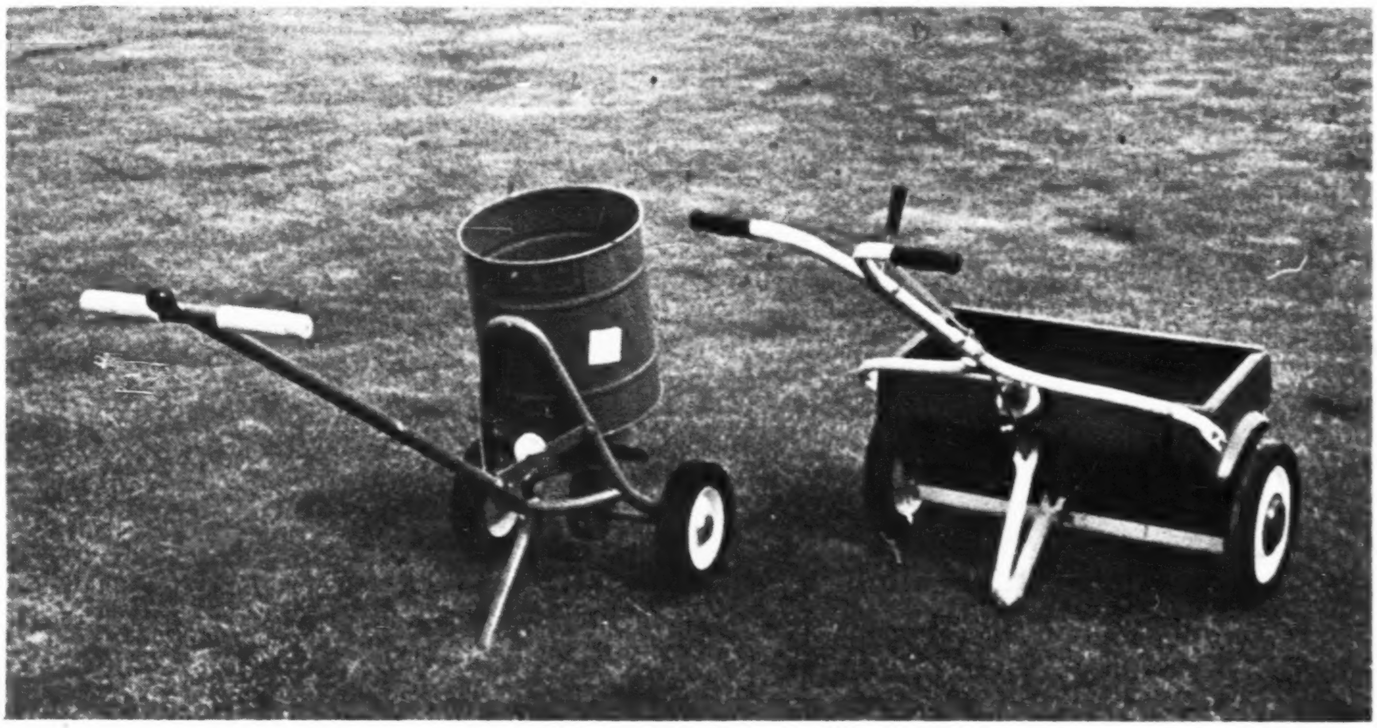


Figure 3. The broadcast seeder-spreader, left, and the hopper seeder-spreader are used to apply lime and fertilizer on home lawns, (they are also used for sowing seed).

The seeder-type spreader applies fertilizer by using an augering device to aid gravity. The fertilizer is applied more closely to the ground in a pattern about 2 feet wide. Drift is less of a problem. This type of spreader is more accurate, but much slower than the broadcast fertilizer spreader. With it, you must be very careful to overlap the wheel marks in the turf when making successive passes. Failure to do so will result in narrow bands of unfertilized turf that in a few days will be a distinctly different color from the fertilized turf.

To prevent burn, fertilizers should be applied only when the grass is dry. For further insurance against burn, dry fertilizers must be washed off the grass immediately after application. This washing is done with a very light watering. Failure to follow those two steps can result in severe turf injury.

Fertilizer spreaders must be calibrated to apply the correct amount of fertilizer. To calibrate, the fertilizer should be placed in the spreader and applied for a distance of ten feet over an area where it can be collected again and weighed. A good surface is a large sheet of paper, a sheet of plastic, or a smooth concrete surface. The rate of application may be calculated using the following formula.

$$\text{Rate in pounds per 1000 square feet} = \frac{\text{pounds collected}}{\text{sq.ft. covered}} \times 1000$$

For example: A seeder-type fertilizer spreader which is 2 feet wide distributes one pound of fertilizer over a 10-foot strip. The rate of application is one pound per 20 square feet. When 1/20 is multiplied by 1000 square feet, the resulting figure (50) is the pounds applied per 1000 square feet (50 lb/1000 sq.ft.).

Although lawn fertilizers may be applied to turf by dissolving them in water and applying the fertilizer as a dilute solution, this method is generally unsatisfactory. When fertilizer is applied by this method through a lawn sprinkler, or even by hand with a hose nozzle, it is very difficult to get an even distribution of the fertilizer over an entire lawn.

Mowing the Lawn

Proper mowing prevents weed invasion and disease and improved drought resistance. Both close mowing and infrequent mowing are injurious. To be mowed properly the grass should be mowed at the correct height and at frequent intervals. Sharp blades are necessary for proper mowing, because a dull mower blade will bruise and tear the grass leaves. Turfgrasses which are cut cleanly by a sharp mower blade will continue to grow and produce more growth than turfgrasses cut with a dull mower blade. Seedling grass plants may be pulled out of the soil by a dull mower.

Selecting a Lawn Mower

Reel mowers have two advantages over rotary mowers. They are not as dangerous, and they are less likely to scalp (cut too short) the turf. However, the types of reel mower which make deep tracks in the turf or which have wheels or rollers that flatten the grass in front of the mower blades are undesirable. Power reel mowers cost more than rotary mowers, but they may be less expensive to operate.

2

Rotary mowers usually cut evenly on level lawns. They are somewhat lighter to handle; and, therefore, they do less wheel damage. However, the rotary mower is very likely to scalp (cut too short) the turf in areas which were not leveled before seeding. Rotary mowers are very dangerous. The turning blade has the power to throw rocks, sticks, and many other dangerous objects at very high speeds for distances of 50 feet or more. A number of people have lost toes or suffered other foot injuries as the result of the careless operation of a rotary mower. (Rotary mowers are also very dangerous to use on wet, slippery, or steep turf areas.)

Flail types of mowers are safer to operate than rotary mowers, and offer the advantage of cutting the grass clippings into very fine pieces.

Mowing Height

Grasses grow from the base of the leaf rather than from the tip of the leaf; otherwise they would not be "mowable." Mowing too close weakens the grass by lowering its food manufacturing capacity. Repeated short mowings may kill the grass.

Different grass species have different growth rates and growth habits. Species such as tall fescue and Kentucky bluegrass tend to grow upright. Merion Kentucky bluegrass tend to grow flatter than either Kentucky bluegrass or tall fescue. On the other hand, species such as the bentgrasses, bermudagrasses, and zoysia grasses grow very low and have a creeping habit of growth. Grasses with a creeping habit of growth may be mowed shorter than grasses which have an upright habit of growth.

A balance between leaf area and root development is required to maintain the health of grasses and to permit normal growth. The best procedure is to mow often enough so that not more than 1/2 inch of the leaf tip is removed at any one mowing. Leaf growth determines the mowing date - not the number of days since the last mowing.

The bentgrasses, bermudagrasses, and zoysia grasses withstand close mowing. They may be mowed as short as 3/8 inch. Usually they are mowed to heights of 1/2 to 3/4 inches on lawns. These grasses have a low habit of growth, because they reproduce by rhizomes and stolons.

Tall fescue and ryegrass should be mowed to the height of 2 to 3 inches. The bluegrasses should be mowed to a height of 1½ to 2 inches or higher. Most lawns in the northeast generally include a mixture of grasses which should not be mowed to a height of less than 2 inches.

Higher mowing heights have certain advantages. At these heights, grass is a good insulator for the soil on hot days. It helps to prevent the soil from drying and hence, protects its roots. Lawns produce larger and deeper root systems, especially if they are watered and fertilized properly.

Frequency of Mowings

Frequent mowings produce dense growth of turf. Irregular mowings allow the turf to become weak and thin. Weeds and insects are more destructive in a weak and thin turf.

New lawns should be mowed as soon as the grass is 2½ to 3 inches high. Established lawns should be mowed in the spring as soon as the turf is ½ inch above the cutting height. In the fall, the mowing should be continued as long as there is grass tall enough to cut. Grasses grow most rapidly in spring and fall, when mowing may be needed every 3 - 4 days. They grow less rapidly in mid-summer heat and may require mowing every 7 - 10 days during that period. Turf over three inches in height tends to be matted during the winter by rain, ice, and snow. Such turf is susceptible to snow mold, a disease that can kill large areas.

Mowing Practices

If lawns are always mowed in the same direction, they may develop an undesirable streaked or banded appearance called "grain." Grain can be prevented by mowing in a different direction each time the lawn is mowed.

Grasses should not be mowed when they are wet. Wet grass tends to tear and bruise. Clippings from lawns mowed while they are wet stick together and form small bunches or clumps. The bunches must be removed, because they are not only unsightly, but also create disease and insect problems.

Double mowing -- that is, mowing twice on the same occasion, will give an especially smooth-looking lawn.

Clippings

If the lawn is mowed at proper intervals, the length of the clippings will be about ½ inch. Clippings of this length may be left on the lawn to decay and return nutrients to the soil. However, too many undecayed clippings will cause thatch problems. If the clippings are long enough to accumulate in bunches or clumps, they should be removed.

Incidentally, grass clippings make an excellent mulch for shrub and flower beds. Several applications, each not over ¼ inch deep, will dry without rotting. Clippings may also be composted.

Thatch

Thatch is the accumulation of dead grass and clippings which build up over a period of time to form a dense mat on the surface of the soil under the leaves of the grass. If thatch builds up, it prevents the penetration of fertilizer and water into the soil. It also blocks aeration of the soil. Thatch provides conditions which are favorable for insects and diseases. Removal of clippings and yearly light applications of lime (to speed break down by microorganisms) are preventative measures.

Renovation of a turf damaged by thatch build-up includes vertical mowing, aerifying, and reseeding.

Edging and Trimming

Most lawns have areas along the edge of drives, walks, and beds which should be neatly trimmed.

Half-moon spades and hand shears are used for this purpose, but their use involves considerable time. Small electric and gasoline engine powered edging tools are more efficient. Steel metal edging strips (with ½ inch protruding from the soil) may also be buried at bed edges. These prevent rhizomes from creeping into the beds, but they are expensive to install.

Aerating the Lawn

Aerifiers overcome the effects of soil compaction by removing small plugs of soil from the lawn. This process loosens and aerates the soil under the turf without drastically disturbing the turf. Compacted soils inhibit fertilizer and water penetration. Lawns on soils which are heavy, poorly drained, or subject to frequent compaction may have to be aerated once or twice a year. This is best done in early spring or early fall. After the plugs are removed from the surface, the lawn is topdressed with a light application of peat or compost.

Watering Lawns

Most established home lawns need to be watered only a few times each year. Lack of water has often been cited as the cause for grass failures, when the failures have actually been caused by poorly adapted grass mixtures, and inadequate or untimely fertilizations, or diseases. Most lawn grasses become dormant during droughts. It is surprising to see how well a brown lawn, seemingly dead from dry weather, will respond to a good soaking rain or irrigation if the lawn has been otherwise properly maintained. During long dry periods traffic should be kept to a minimum to avoid permanent damage to the turf.

Amount and Frequency of Watering

The need for water on lawns is determined by (1) the type of soil, (2) the kinds of grass, and (3) the climatic conditions.

The type of soil determines the quantity of water that may be stored in the soil and the speed with which it is absorbed. Established lawn grasses growing on sandy soils need water more frequently than the same grasses growing on clay soils. Water enters sandy soil rapidly, but it is also used up relatively quickly. Water should be applied more slowly to clay soil to avoid wasting it through run-off.

Different varieties of grasses have different water requirements and tolerances to drought conditions. The lower the water requirements of a grass the more tolerant it is to drought conditions. Rough bluegrass, annual bluegrass, and creeping bentgrass have the highest water requirements. Bermudagrass, zoysia grass, Kentucky bluegrass, and the fescues, on the other hand, are the most drought tolerant.

Both the fescues and the bluegrasses become semi-dormant and grow very slowly, if at all, during periods of high summer temperatures. Watering during these periods may only stimulate weed growth.

When a grass plant needs water, it wilts. Temporary wilting (for several hours) is caused by hot weather and high winds which remove water from the leaves faster than the roots can absorb it. Chronic wilting (for several to many days) occurs during long hot periods of drought, lasting several weeks or more. Under this condition the lawn grasses turn brown and appear dead. However, a thorough watering will revive the plants and restore their green color.

To insure good growth and to meet the water requirements of an established lawn turf, enough water should be applied in one application to penetrate the soil to a depth of 6 to 8 inches. Watering to this depth promotes a deep root system. A deep root system helps the lawn to withstand drought. Shallow, frequent watering may promote shallow root systems which cannot absorb water from deeper soil layers when the upper layers become dry.

Heavy, frequent watering may saturate the soil, forcing out the oxygen needed by grass roots. Injury and death of the grasses may be caused by this type of overwatering.

The Time to Water

It makes little difference whether a lawn is watered in the morning or afternoon. Watering in the sun will not scald or burn grass plants. It may even be beneficial. It helps cool the plants. Watering during the heat of the day may require slightly more water, because a higher rate of evaporation is caused by higher temperatures. Although watering at night decreases the quantity of water needed, it also increases the humidity, and thereby, keeps the plants wet or damp for a longer period of time. Prolonged dampness favors the development of diseases.

Rate of Applying Water to the Lawn

Water should be applied slowly enough to be absorbed and long enough to penetrate 6 inches into the soil.

The rate and the quantity of water applied can be measured by placing empty tin cans at different positions in the area being watered. These cans should be placed along the diameter of a circular spray pattern or along both the horizontal and vertical axes of a rectangular spray pattern. When one inch of water has accumulated in the cans, enough water has been applied to penetrate 6 inches into most kinds of soil. If cans in certain locations are found to have much less or much more water than the others, the watering device is not distributing the water evenly over the area.

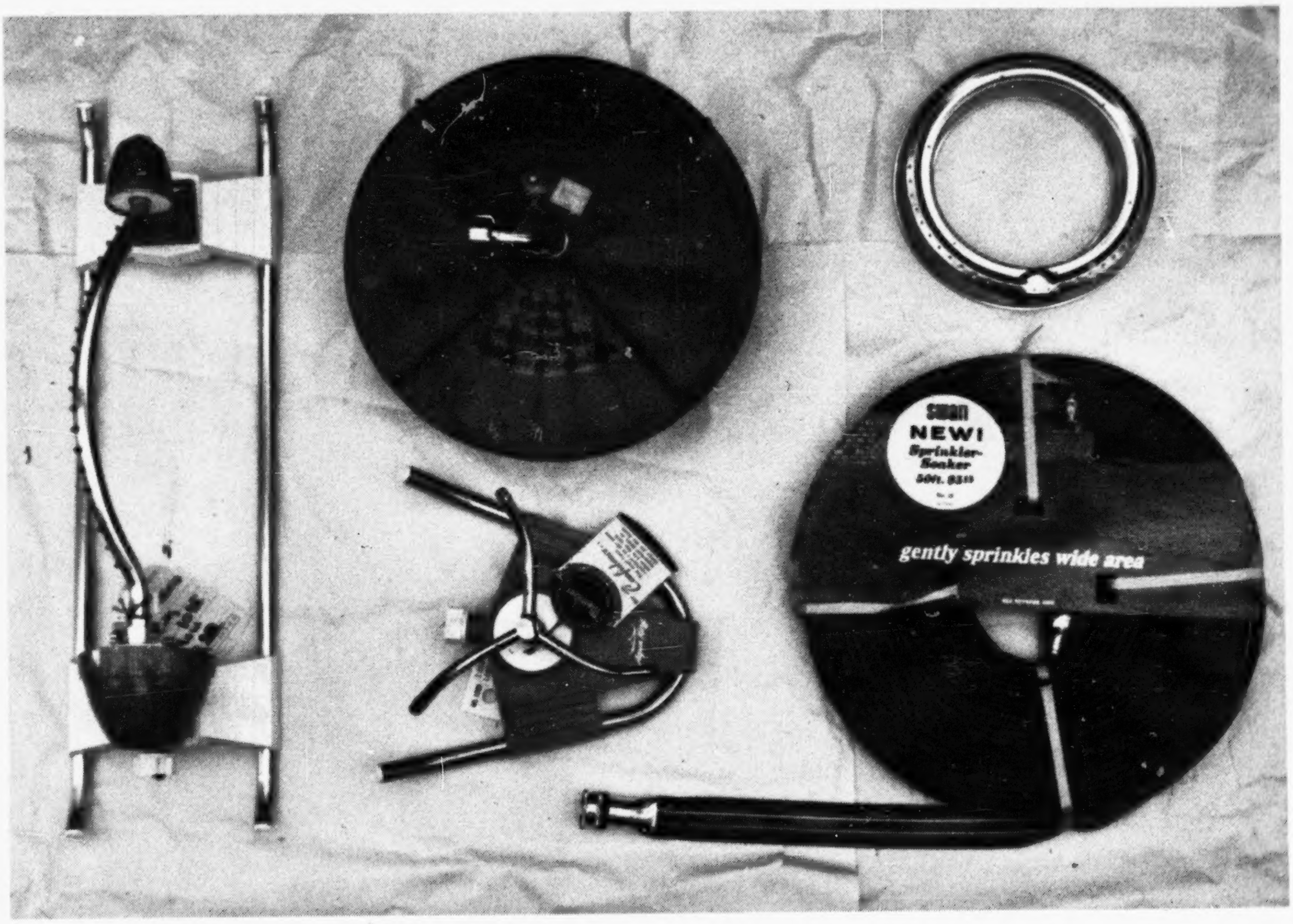


Figure 4. Portable lawn sprinklers.

Equipment Used to Water the Lawn

There are several types of watering systems for lawns: the perforated hose, the rotary sprinkler, the traveling rotary sprinkler, and the oscillating (back and forth) sprinkler. Permanent types have underground piping and sprinklers with either stationary or pop-up heads.

When choosing equipment to water lawns, you should know that any watering device will be satisfactory as long as it applies water to the entire grass area at a uniform rate. The water should be absorbed without run-off. The choice of model depends on the size of the lawn and the cost.

A traveling sprinkler provides uniform water coverage, but is more expensive than non-traveling types.

Simple timers to turn off the water automatically may be installed in any lawn sprinkling system.

Controlling Lawn Pests

There are four essential steps in a good program for controlling lawn pests: establishing a good turf, following regular maintenance, examining the lawn weekly so pest problems are diagnosed early, and diagnosing diseases properly.

The establishment of a good turf is basic to preventing weed, insect, and disease problems. If a homeowner has been successful in getting the proper grass mixture growing, he will have fewer problems with turf pests. Weeds grow less easily in a well-established lawn than in a poor lawn. Diseases are less of a problem in a lawn that has been properly started.

Once a good turf has been established, it is very important that a regular schedule of maintenance practices be followed to help reduce problems with pests. Mowing at the proper height and proper time, adjusting the pH, and applying fertilizer according to soil test results are forms of insurance against weeds, insects, and diseases.

It is surprising how much you can learn about a lawn by taking time to examine it. The earlier a problem is noticed, the sooner it can be diagnosed and controlled, and the less likely it is to become a serious problem.

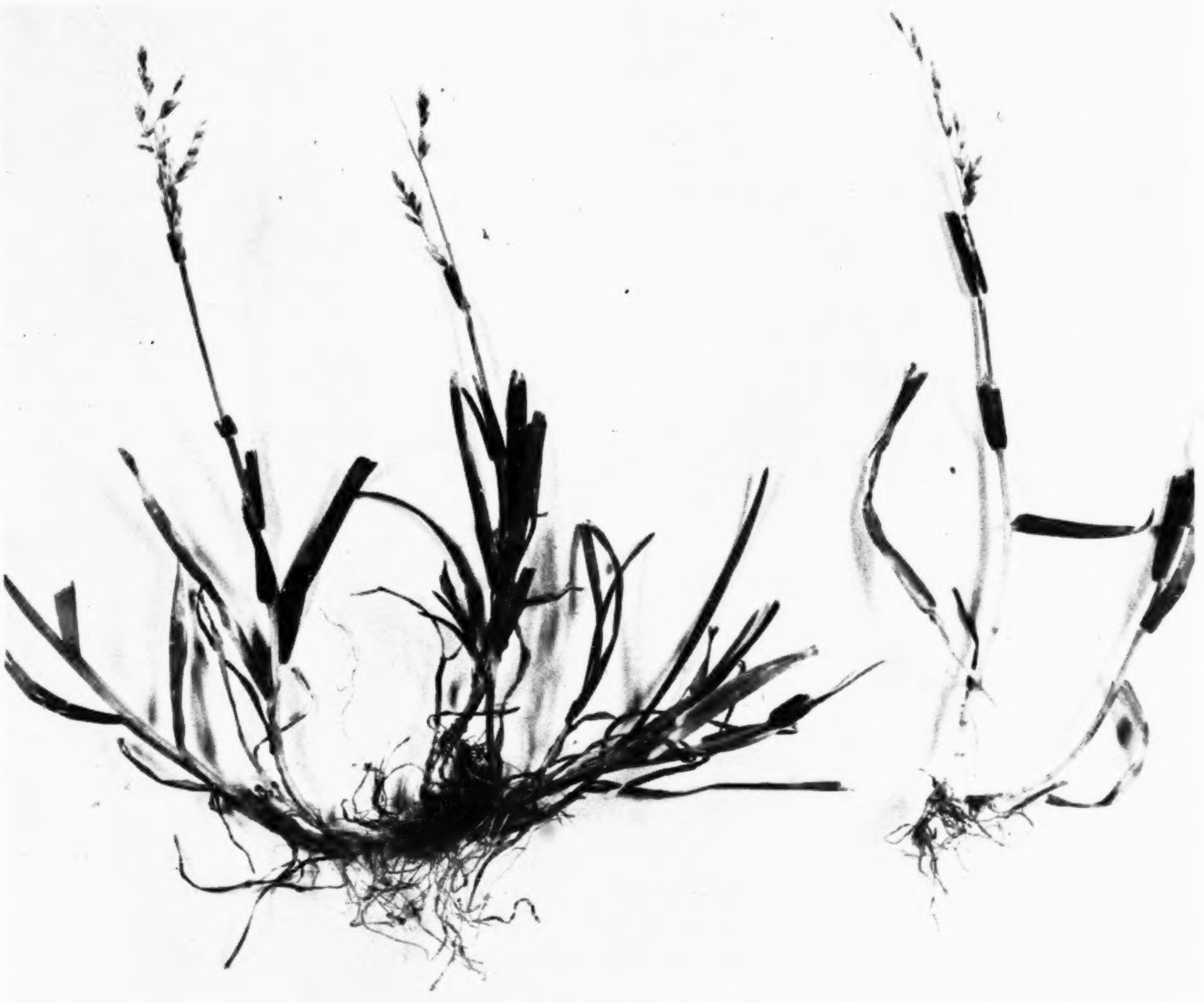
Information has been included in this publication which should be helpful in identifying weeds and diagnosing disease problems. References listed in the bibliography may also be used for this purpose. Some diseases are difficult to diagnose. Your agricultural teacher, county agent, or State University turf specialist can help you in such cases.

Turfgrass Weeds

A weed is any plant growing out of place. Some common weeds which invade lawns are crabgrass, dandelion, buckhorn plantain, and broadleaf plantain. The weeds on the following pages are often found in home lawns. Growth characteristics and weed controls are listed. You should update your weed control measures as new chemicals are made available.

Applications of weed killers (herbicides) should be made when the weather is relatively cool and growth is rapid. This period is usually during the first and second week in May and the first and second week in October. Mid-summer applications may be ineffective. A herbicide mixture of 2,4-D and 2,4,5-T, appropriately diluted and applied, will kill most kinds of lawn weeds. The material should be applied to the entire lawn, rather than to "spots." This assures that unseen weed seedlings will be destroyed. Granular herbicides, which may be applied with a hopper-type fertilizer spreader, are less likely than sprays to cause injury to shrubs. Herbicides diluted in water and sprayed on the lawn form fine droplets that may be carried in air currents and cause severe injury to tomatoes, grapes, and many other highly sensitive plants. A sprayer used for herbicides should never be used for applying insect and disease control materials. Herbicides absorbed by the gaskets of the sprayer can become dissolved in solutions used afterward in sufficient quantity to cause injury to desirable plants.

For further information on pest control, see Turf Management, chapters 8-10, Reference No. 27. Some of the more common weeds are described and pictured on the following pages. Control measures are also discussed.

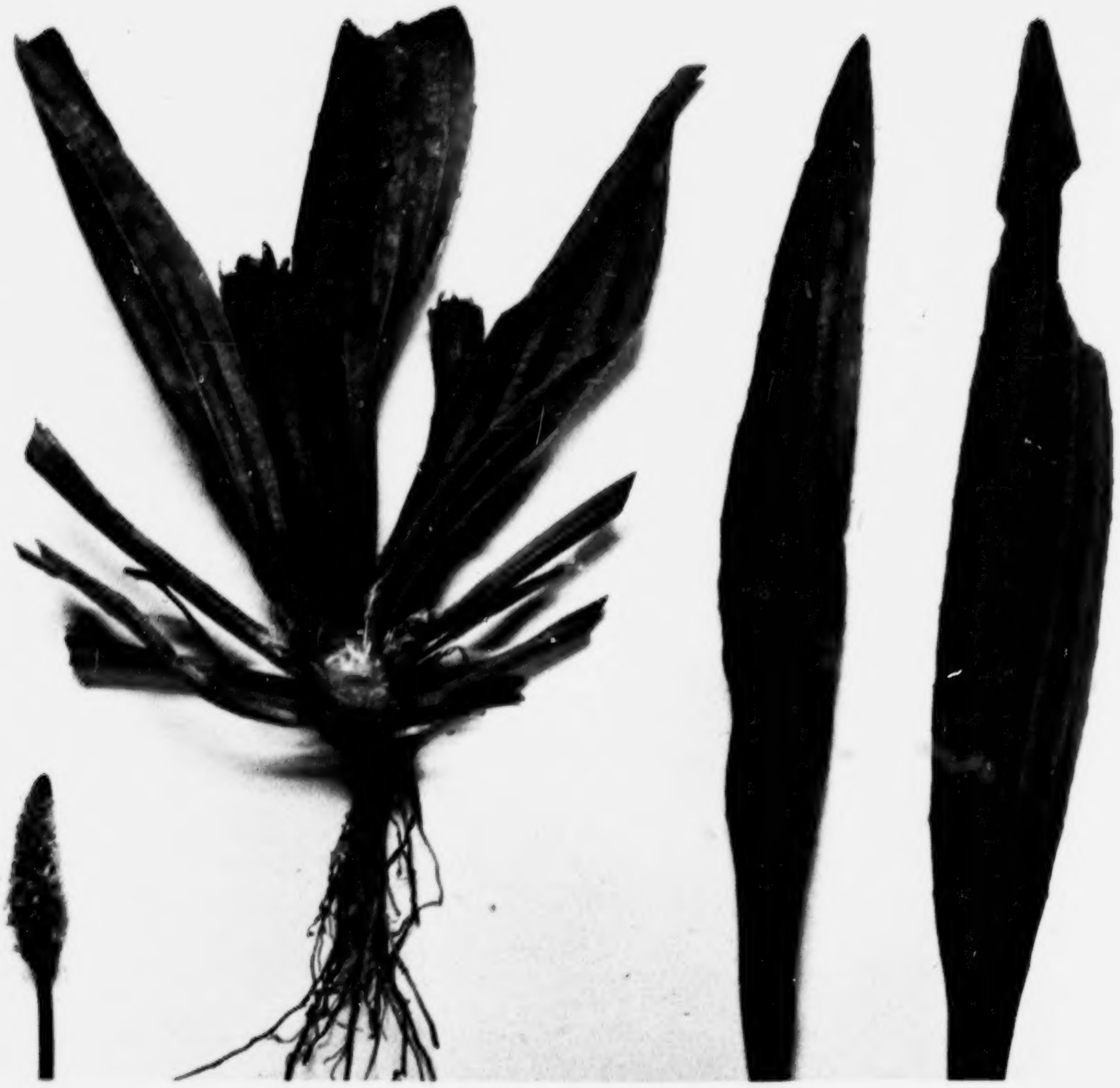


Annual Bluegrass (Poa annua)

Annual Bluegrass is a winter annual which dies out in mid-summer heat. It has a clump type of growth, produces seed heads at any mowing height, and grows rapidly in spring and fall. It can become a serious problem on golf greens.

1. Leaves are similar to Kentucky bludgrass, but lighter green.
2. Clump type of growth without rhizomes.
3. Produces seed heads freely in spring and fall.

Control: Provide good soil aeration to encourage other grasses; withhold water in late summer and early fall when seeds in this weed germinate. Fertilize the turf in late summer to stimulate growth of desirable grasses.

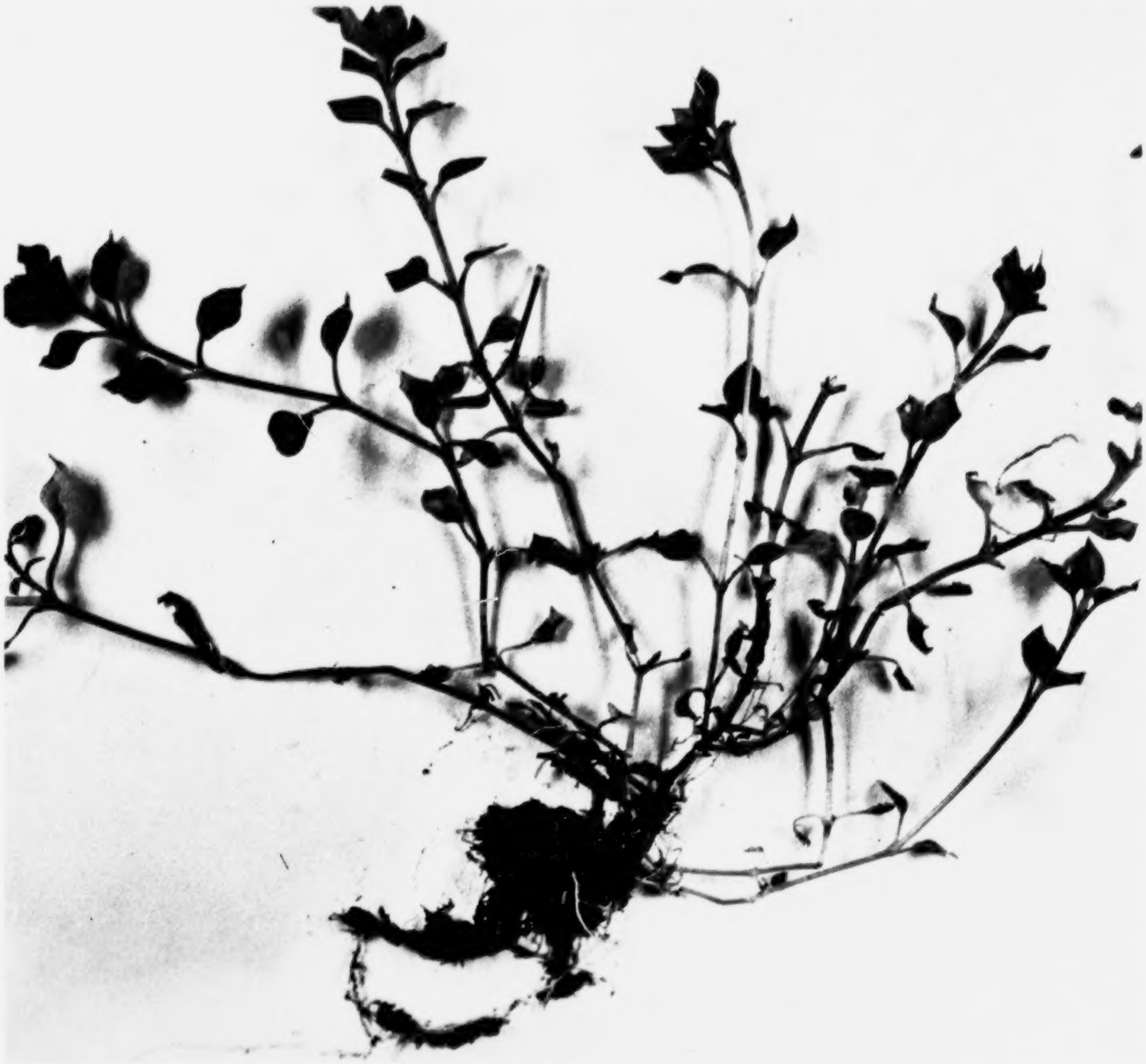


Buckhorn (Plantago lanceolata)

Buckhorn is a very common perennial weed in the northeast. It reproduces from seeds.

1. Lance-shaped, firm, parallel-ribbed leaves, covered with soft hair, grow from the base of the plant forming a basal rosette.
2. The stems are erect, long, and leafless, ending in a flower spike.
3. The seedhead is a cylindrical spike, about one inch long at the end of a long stem.
4. The roots are fibrous, wiry, and shallow.

Control: Buckhorn may be controlled with 2,4,-D applied in the fall or early spring. Best control may be achieved when the plants are in active growth. Repeat 2,4-D as necessary for complete control.

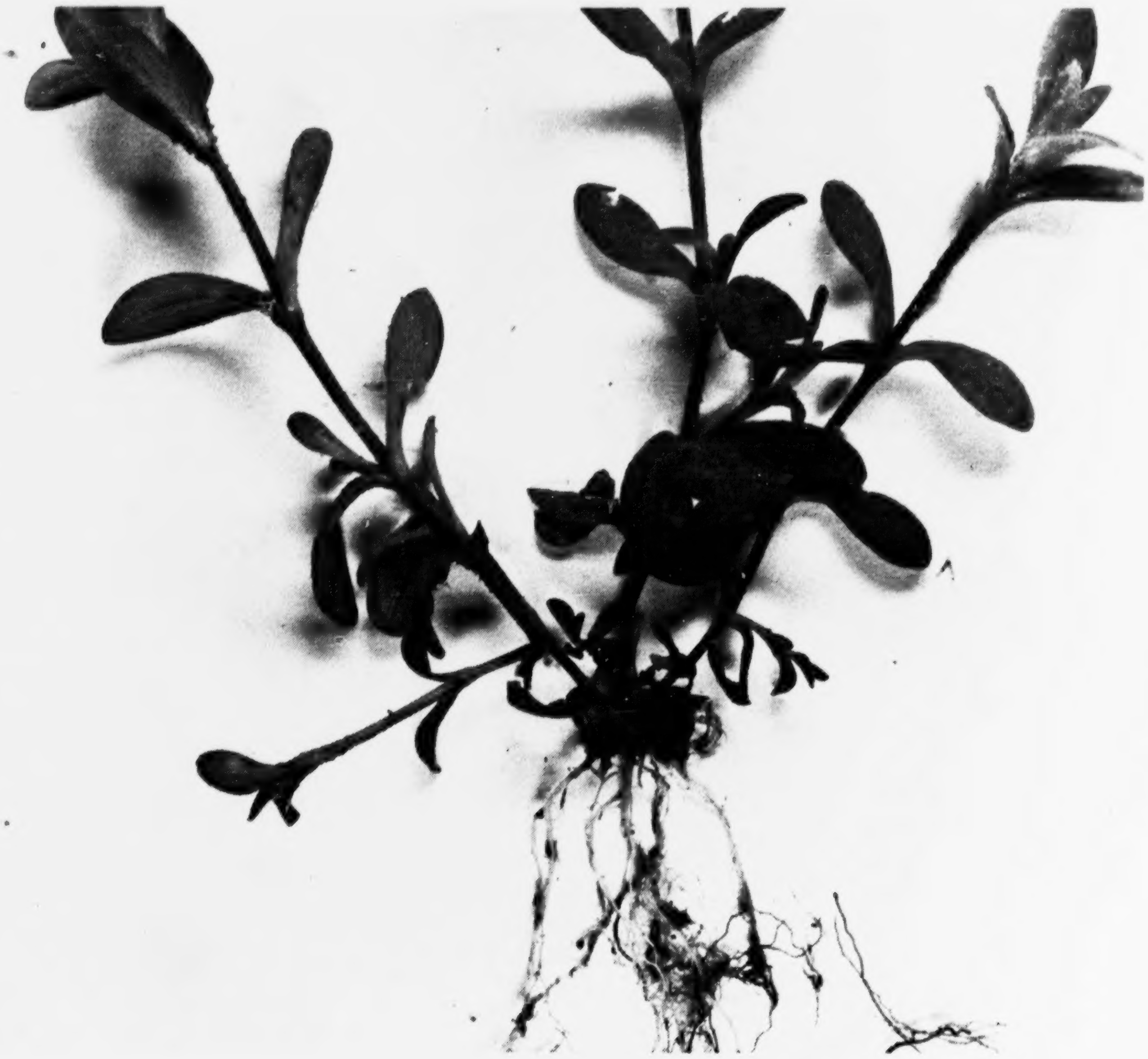


Common chickweed (Stellaria media)

Common chickweed is an annual that produces flowers and seeds from early spring into late fall. It forms roots at the nodes, is very persistant, and will withstand close mowing. It is particularly invasive in compacted soils.

1. The leaves are small and nearly round, shiny, and light green.
2. The stems are soft and nearly transparent.
3. The root system is fine and shallow-rooted.

Control: Applications of Silvex, Mecoprop, or Dicamba control Common chickweed.

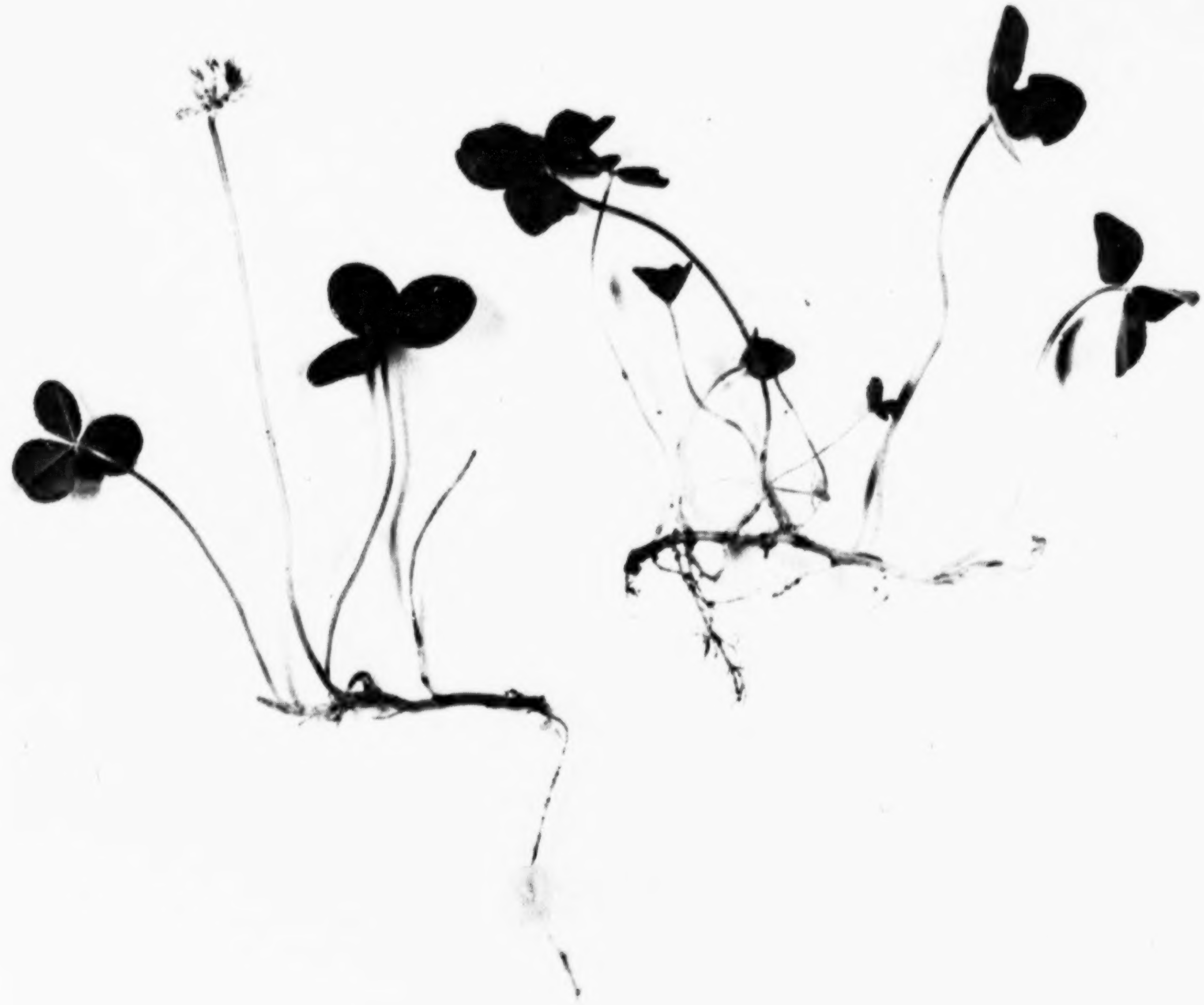


Mouse-Eared Chickweed (Cerastium vulgatum)

Chickweed is a perennial weed which reproduces by seed and sometimes by root development on the lower branches at the nodes. It is very persistent, easily penetrates thick turf, and survives close mowing.

1. The leaves are small, shaped like the ear of a mouse, hairy, opposite, and attached directly to the stem.
2. The stems are hairy, slender, partly spreading to erect.
3. Flowers are very small and white.
4. The root system is small and fibrous.

Control: Silvex, Mecoprop, or Dicamba may be used to control chickweed.

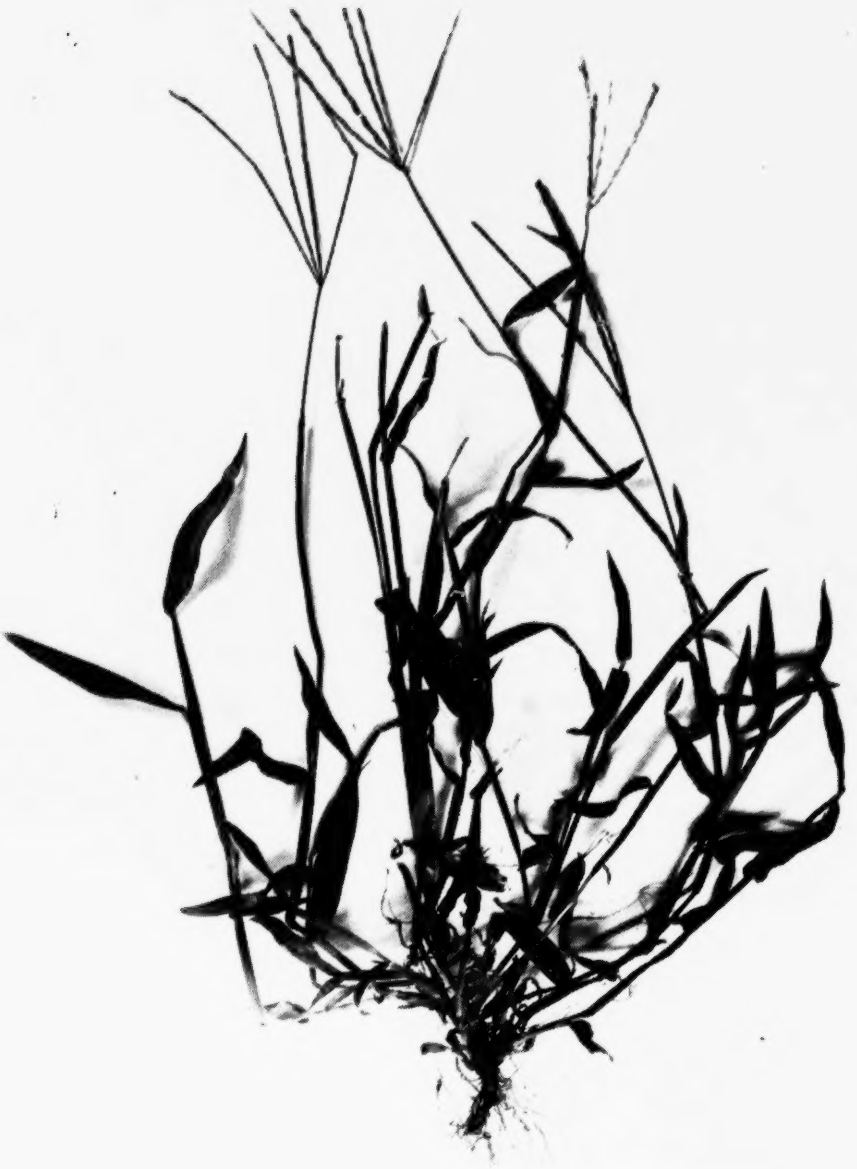


White Clover (Trifolium repens)

White clover is a perennial with a deep taproot. The creeping stems root at the joints. Even under close mowing, it produces seed heads. It is particularly invasive in compacted soils.

1. White to pink, round flower heads of pea-flowers.
2. Each leaf consists of three heart-shaped leaflets joined at the points.
3. It has creeping, reddish stems.

Control: High nitrogen levels in the soil cause desirable grasses to crowd out white clover; 2,4-D and 2,4,5T applied in cool weather give effective control.

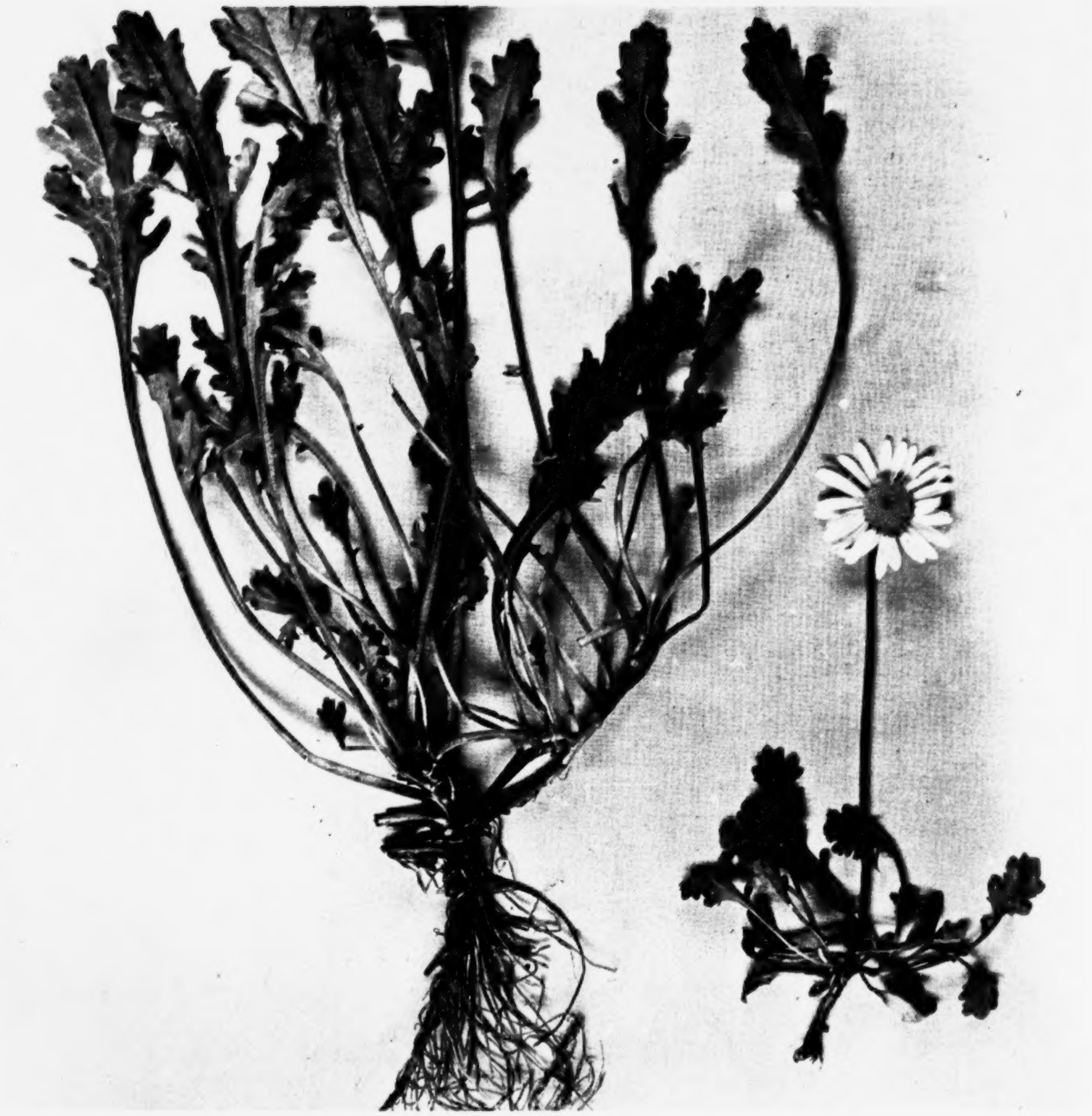


Crabgrass (Digitaria sanguinalis)

Crabgrass is a summer annual plant that starts growing in mid-spring and lives until the first hard frost.

1. Seedlings are light green in color.
2. Leaves are pubescent (hairy) and wide on Digitaria sanguinalis and smooth on Digitaria ischaemum.
3. The stems are strong and recline as they become older.
4. Each stem bears three to ten finger-like spiklets at the top. The seeds occur in pairs in each spikelet.

Control: Control consists of good cultural practices combined with chemical herbicides used at the proper time. Use a post-emergent chemical such as DCPA, Bensulide, Siduron, Azak, DMPA, disodium methyl arsonate, or amine methyl arsonate about 2 weeks before expected crabgrass germination (when Forsythia flowers).

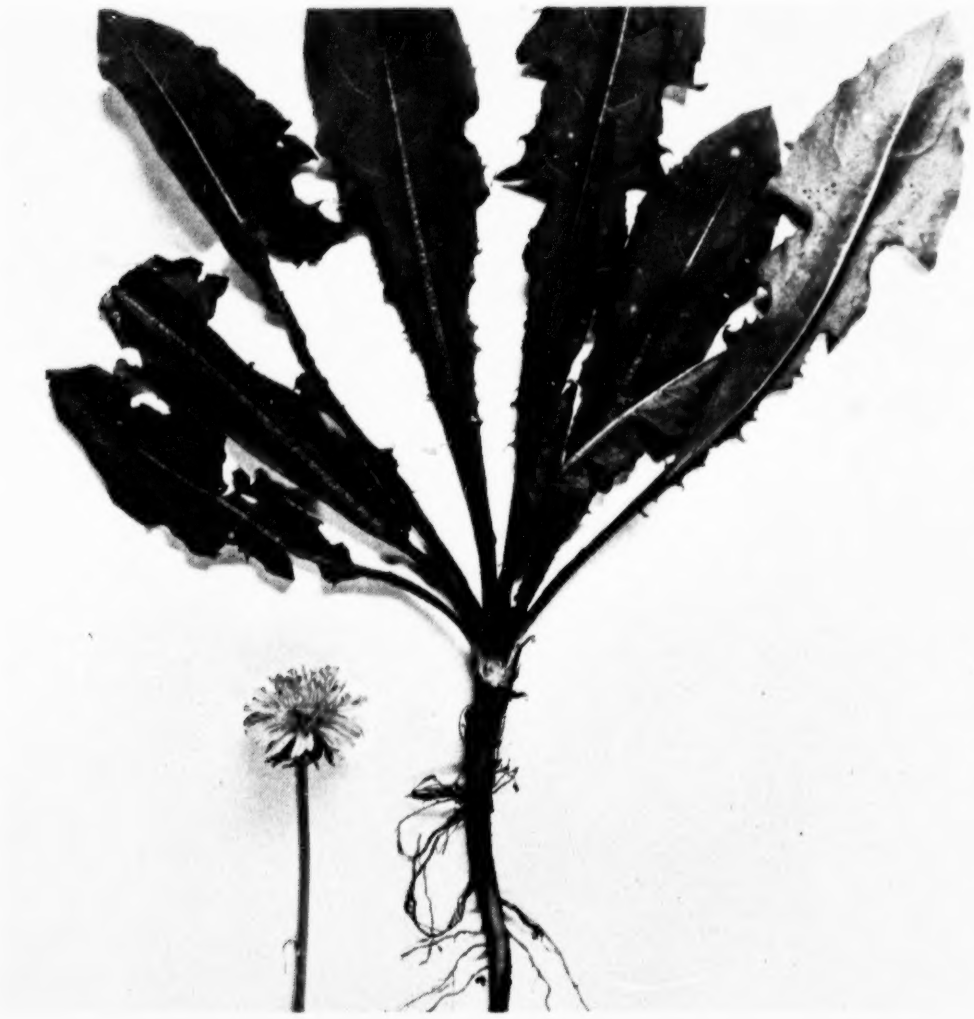


Ox-eye Daisy (Chrysanthemum leucanthemum)

Ox-eye daisy is a perennial weed which spreads by seeds and rhizomes.

1. Most of the leaves grow out of the crown, forming a rosette, and are toothed, cut, or divided.
2. The stems grow upright. If left uncut, they will grow to heights of 3 feet.
3. The flower is distinctive. It has white petals (20 to 30) and a yellow center.

Control: There is no sure chemical control of ox-eye daisy. Removal by hand is recommended.

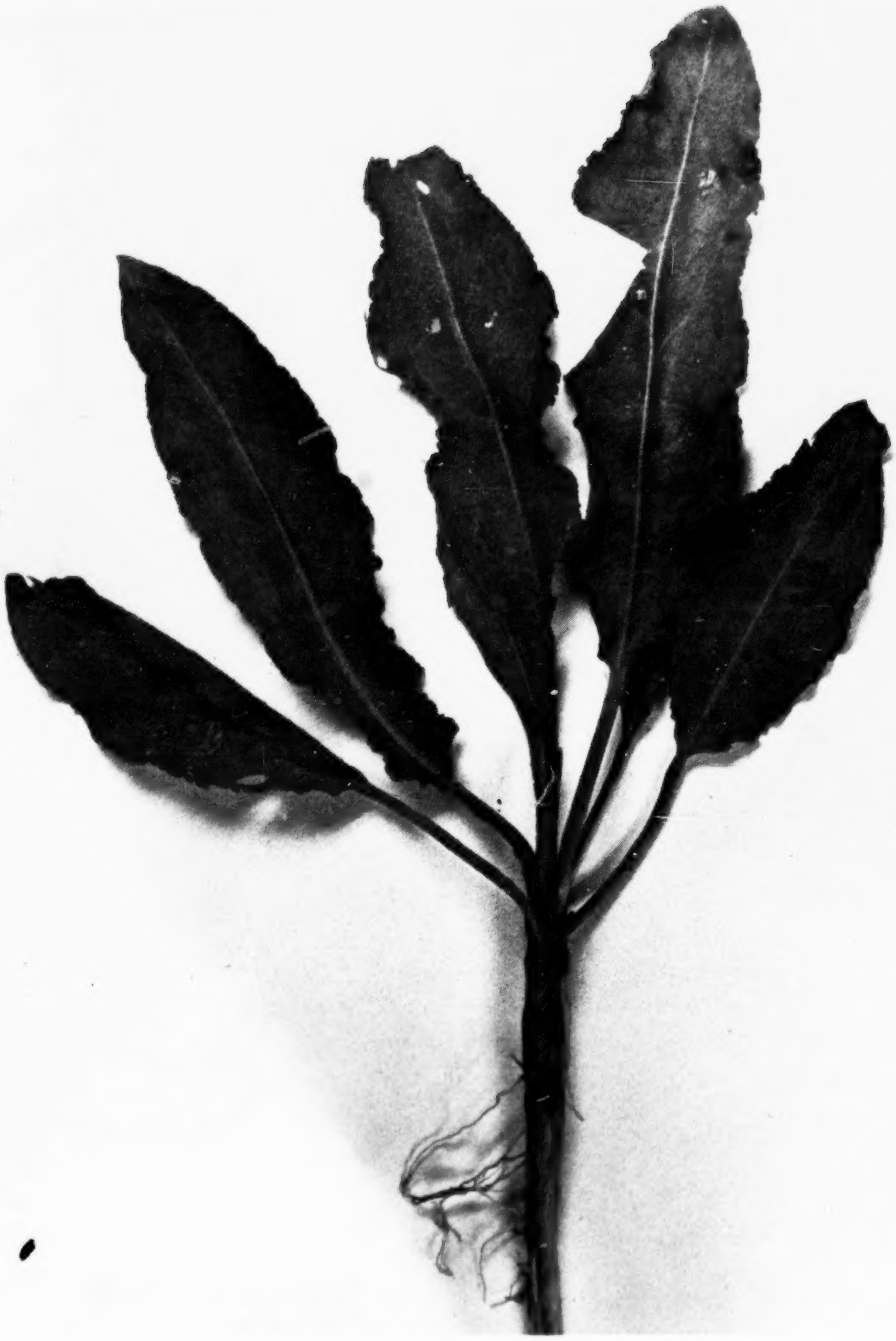


Dandelion (Taraxacum officinale)

Dandelion is a perennial which reproduces from seeds and root sections.

1. The leaves are simple, with many sharp lobes that point backward. They are 3 to 10 inches long, contain a milky juice, and come from a crown at or slightly below the surface of the ground. They form a rosette 6 to 12 inches in diameter.
2. Smooth, hollow stalks bear a single golden yellow flower.
3. Each seed has a slender tip bearing a tuft of hair. When ripe, the head has a white spherical appearance.
4. Dandelion has deep tap roots which feed well below the area of grass roots. New sprouts may come from roots or root segments.

Control: Dandelion is controlled with 2,4-D applied as a spray or in a dry formulation in the fall or spring. One to two treatments using enough spray to cover the leaf area uniformly will control dandelion.

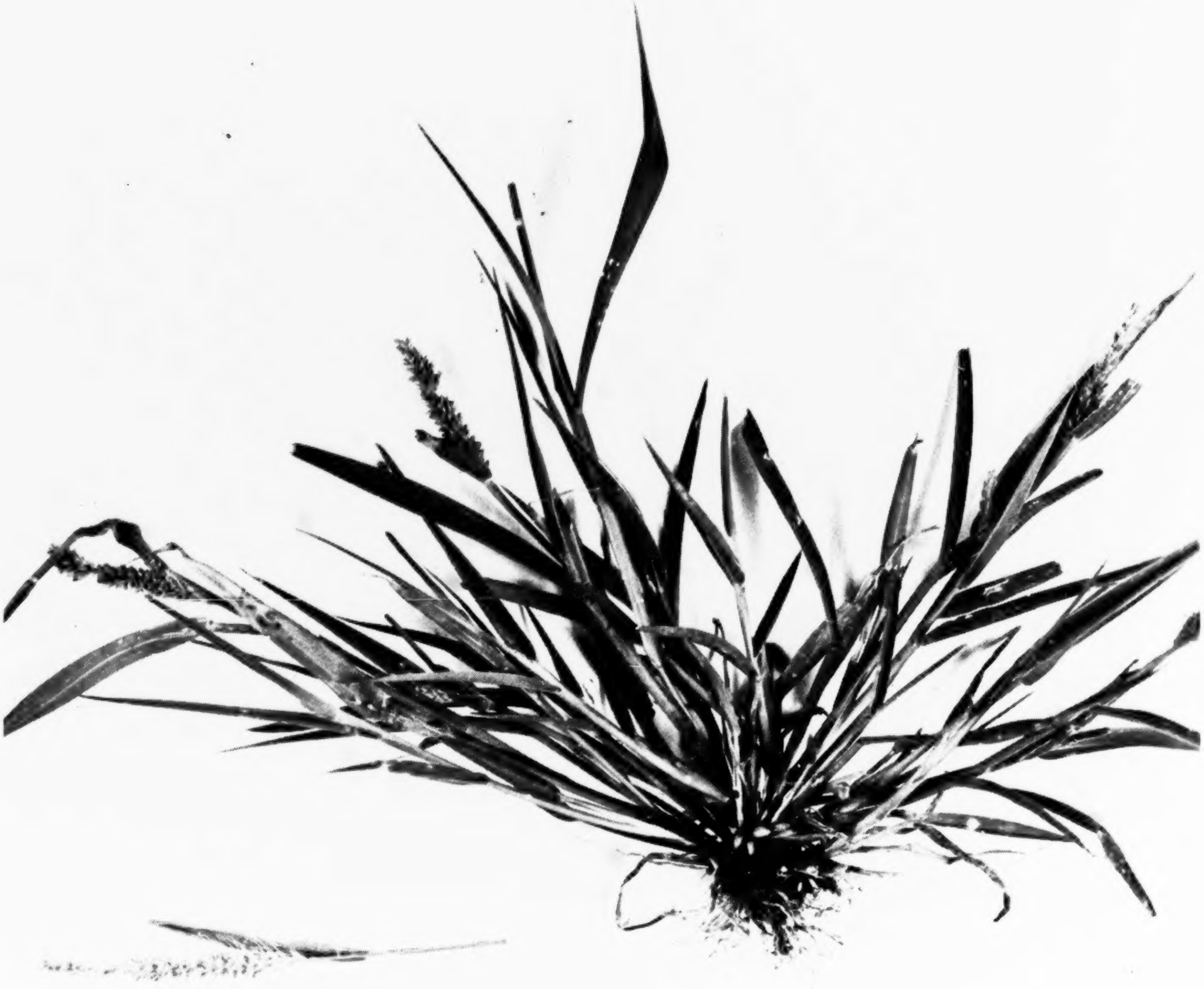


Curly Dock (Rumex crispus)

Curly dock is a perennial weed.

1. The leaf has distinctive crinkled edges and a prominent mid-vein. They are broad and non-hairy.
2. The stem may grow to a height of 3 feet if left uncut.
3. Seeds are produced on the stem.

Control: Curly dock is easily controlled with 2,4-D.

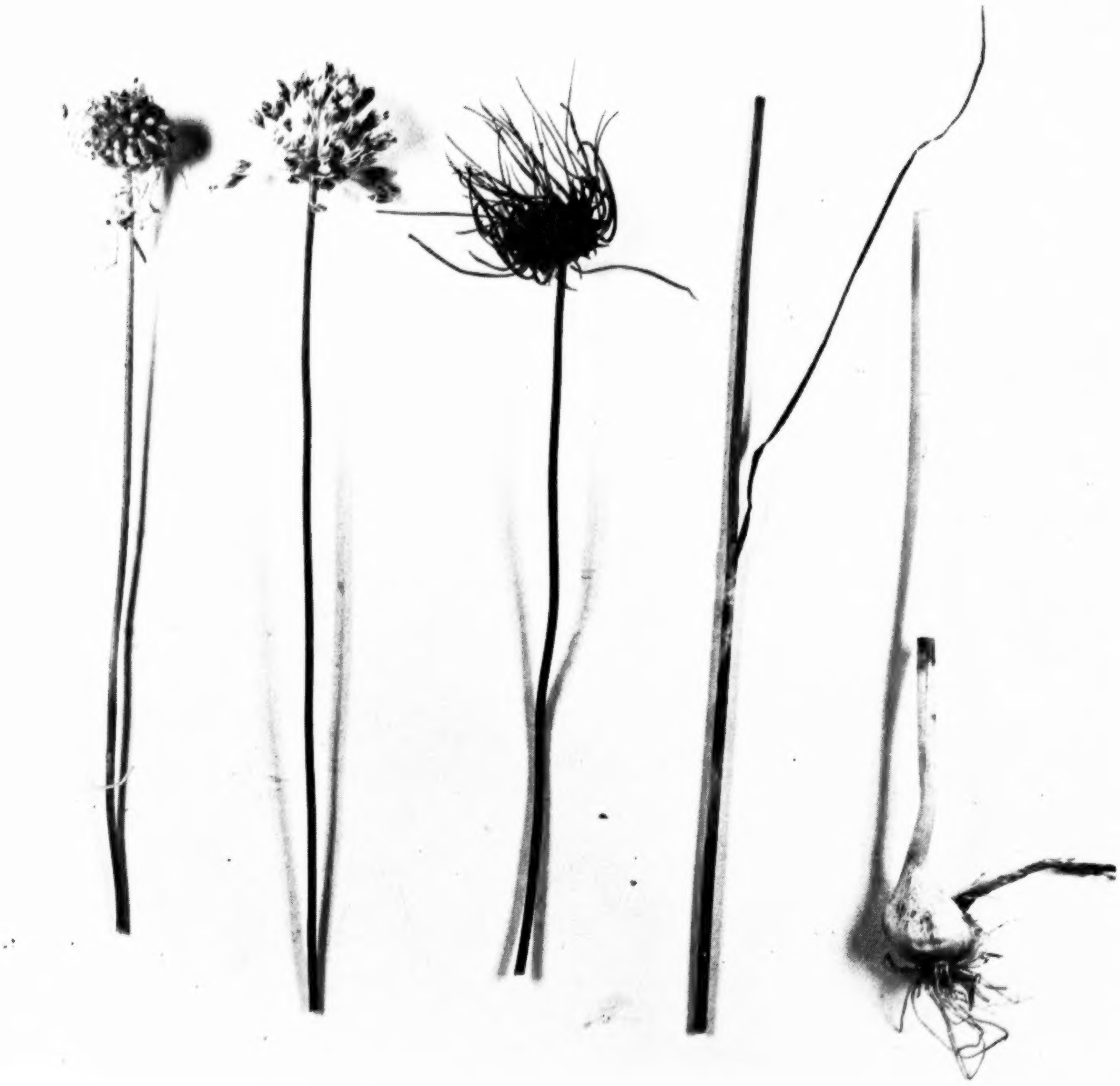


Yellow Foxtail (Setaria glauca)

Yellow Foxtail is an annual grass that may be a problem in new lawns started from seed. It forms a clump type of growth.

1. Leaves have broad blades, and are light green.
2. Leaf bases are reddish.
3. Seed heads are compact, with dense, fine, soft, reddish hairs.

Control: Hand removal; it does not withstand regular mowing very well. In a turf receiving good care it is seldom seen the second year.

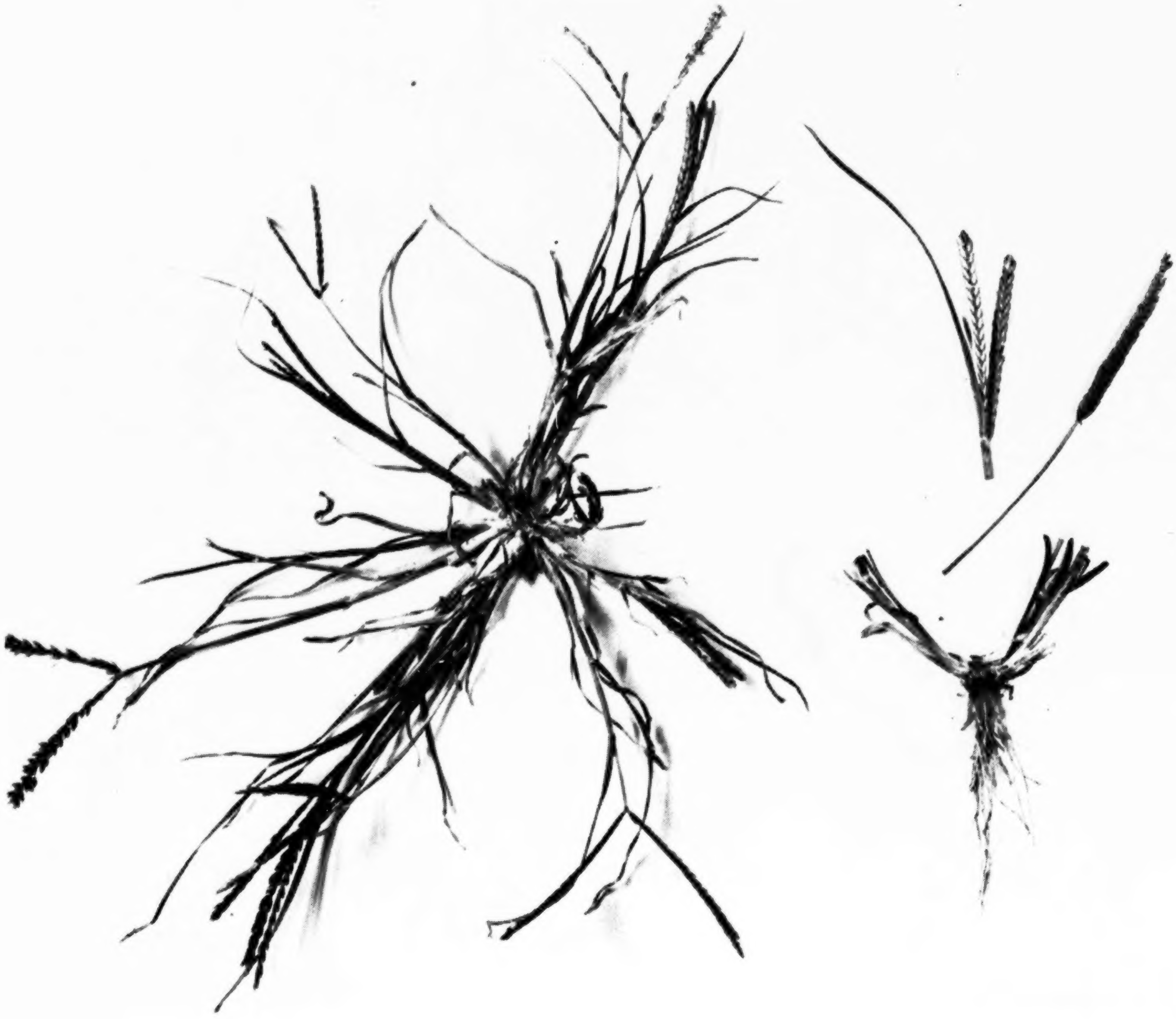


Wild Garlic Species

Wild garlic develops from underground bulbs or from aerial bulblets borne on the flower stalks. The odor of crushed foliage is offensive.

1. Leaves are slender, tubular, and upright.
2. Flower stalks are removed in mowing.
3. Crushed leaves have a distinct garlic odor.

Control: Spray with ester form of 2,4-D in spring and fall for several successive years; persistent infestations may require 4 years of treatment.

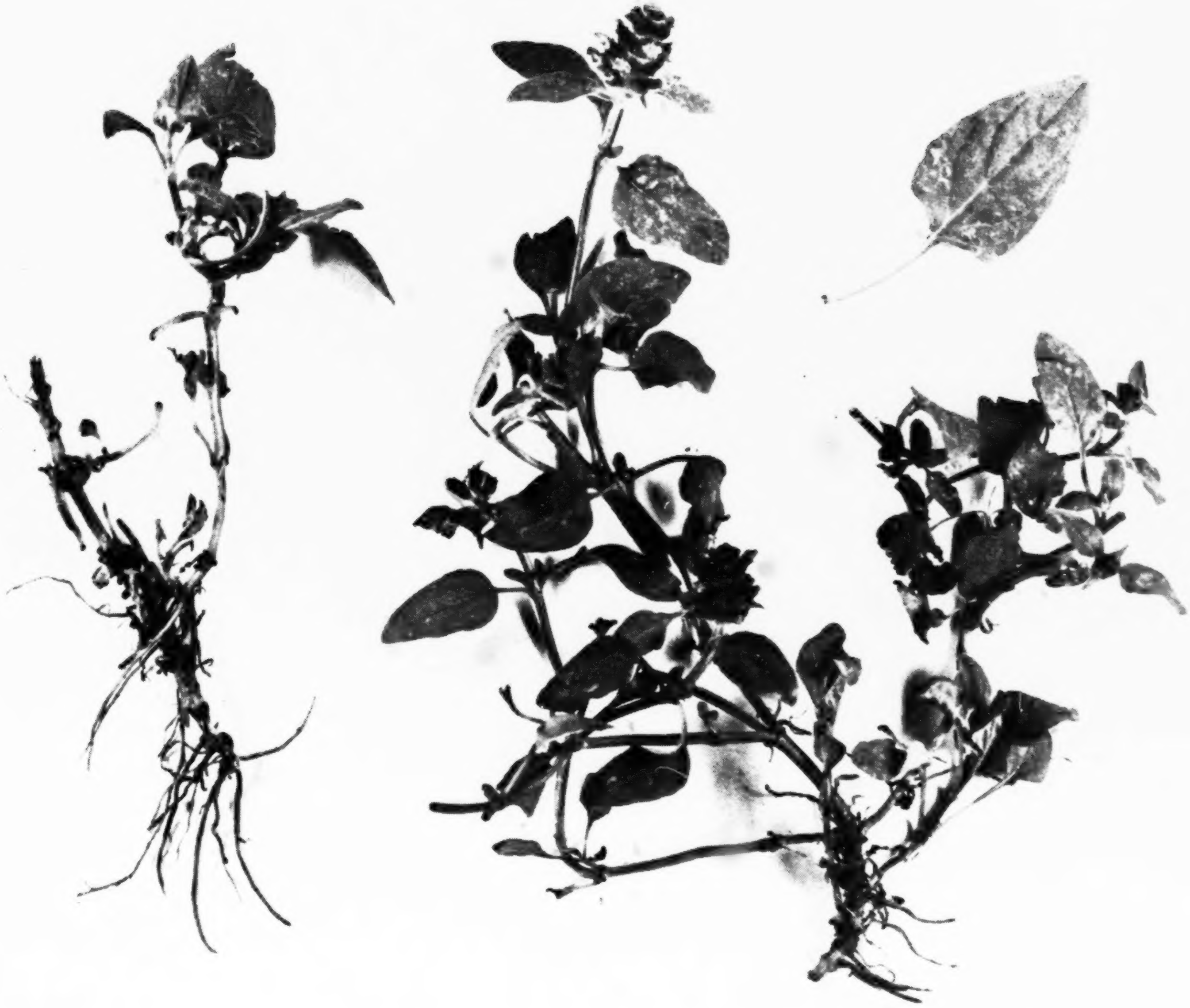


Goosegrass (*Eleusine* *indica*)

Goosegrass is an annual grass which is also called "silver crabgrass." It is most common on compacted soil.

1. The leaves are grass-like with a silver color in the center.
2. The stems are low growing and form a dense rosette. They *do* *not* root on contact with the soil.
3. The seedheads are four-armed with seedheads arranged one below the other. The seedheads look like a closed zipper.

Control: There is no effective control but DCPA will reduce the severity of the infestation.

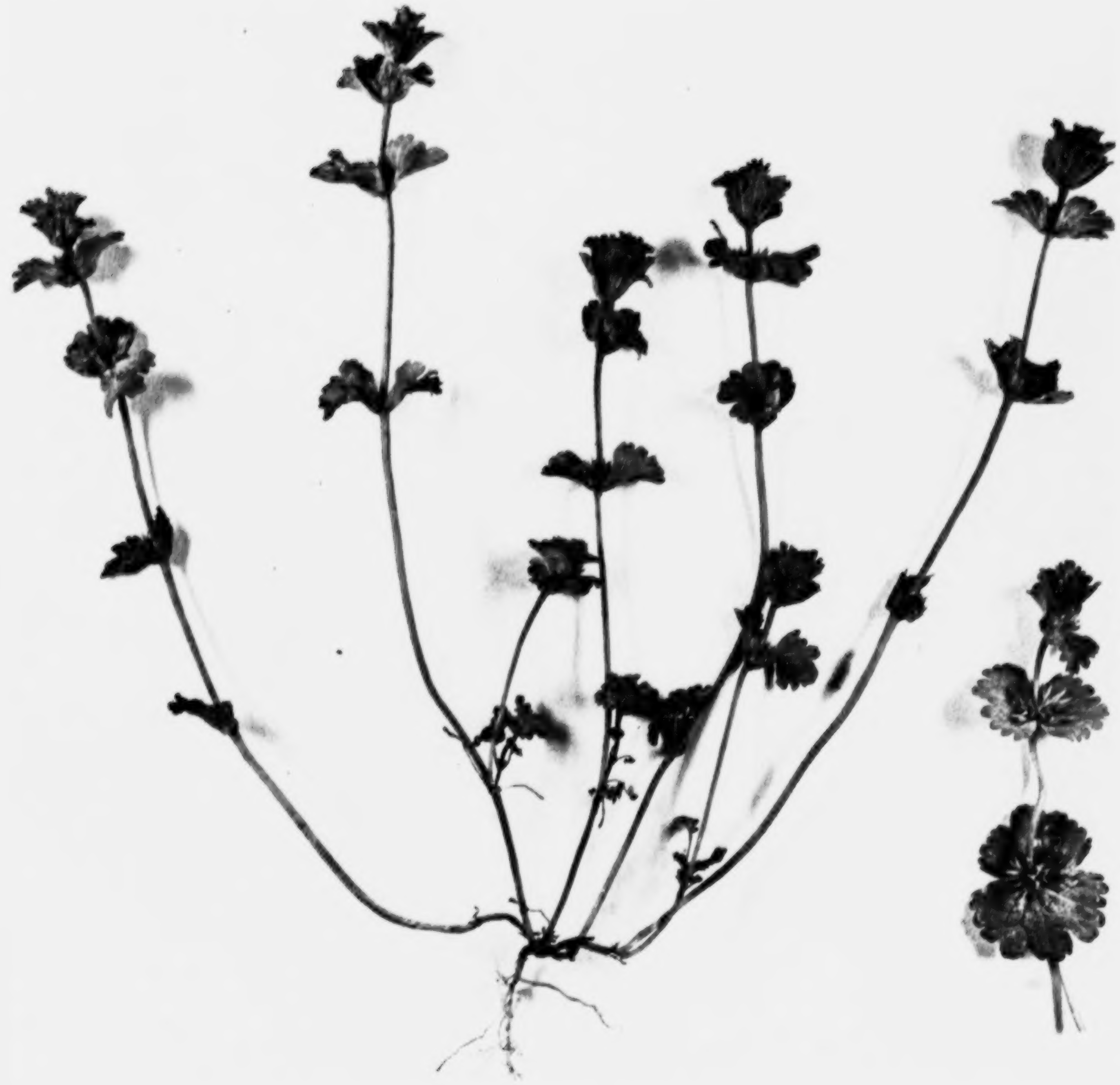


Heal-all (Prunella vulgaris)

Heal-all, also called Self-heal, is a creeping perennial that belongs to the mint family. Heal-all spreads by creeping stems above the ground. It forms a solid mat over the ground that crowds out desirable grasses.

1. The flowers are tiny, varying from purple to white, and borne in a dense head.
2. The leaves are opposite, oblong, narrowed toward the tip, and slightly toothed.
3. The flowers terminate the stems that grow 6 to 12 inches high.

Control: Best control results with the use of 2,4,5-T or Silvex and 2,4-D applied while the plants are actively growing. Retreatment may be necessary.

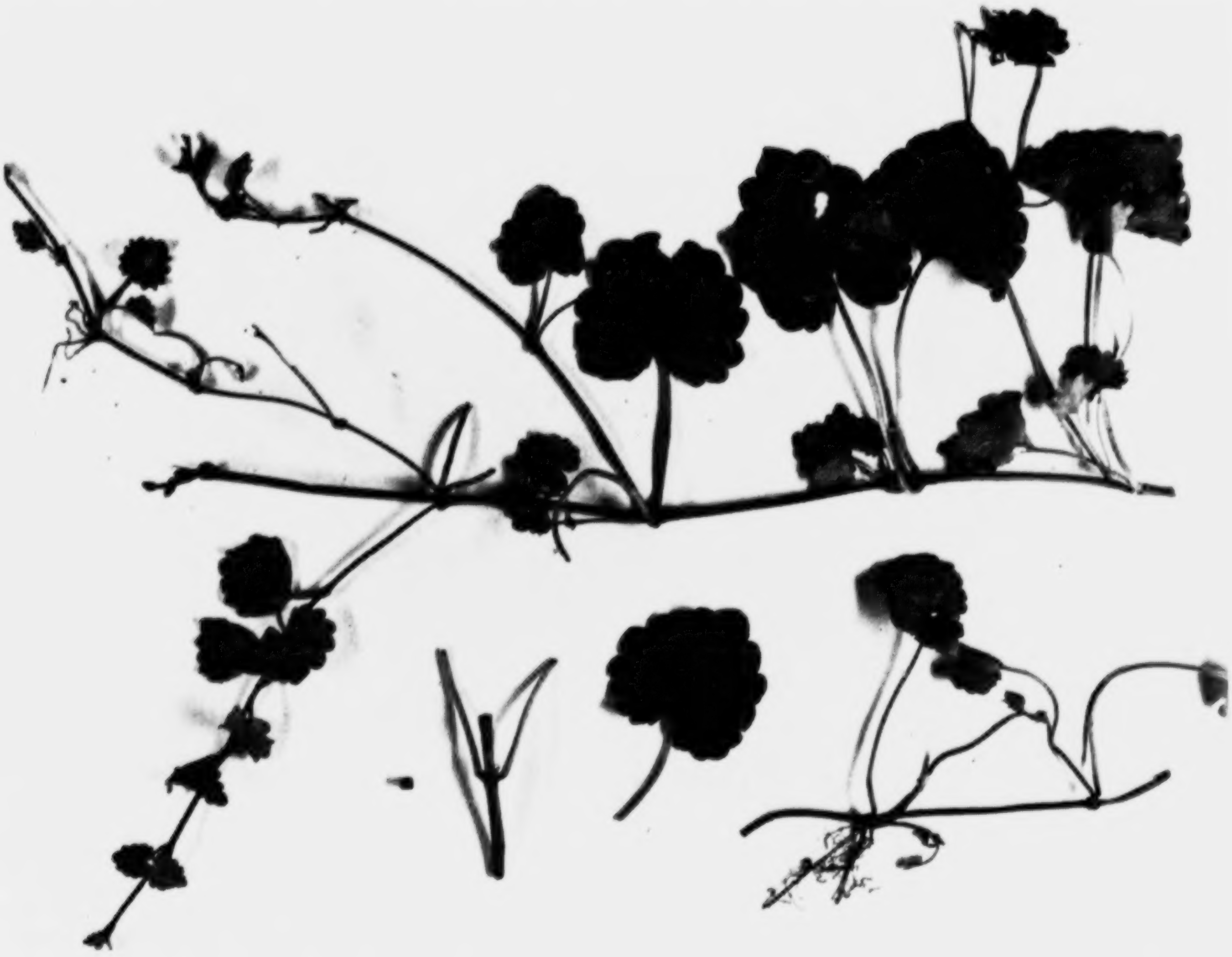


Henbit (Lamium amplexicaule)

Henbit is a winter annual or biennial with prostrate stems that root at the joints. It forms a dense mat. It is very invasive.

1. Leaves are kidney-shaped, and scalloped.
2. Leaves are opposite one another on the stem.
3. Stems are square and often reddish.
4. It has lavender flowers from May through August.
5. Flowers are in tight clusters in the upper leaf axils.

Control: 2,4-D applied in the spring.

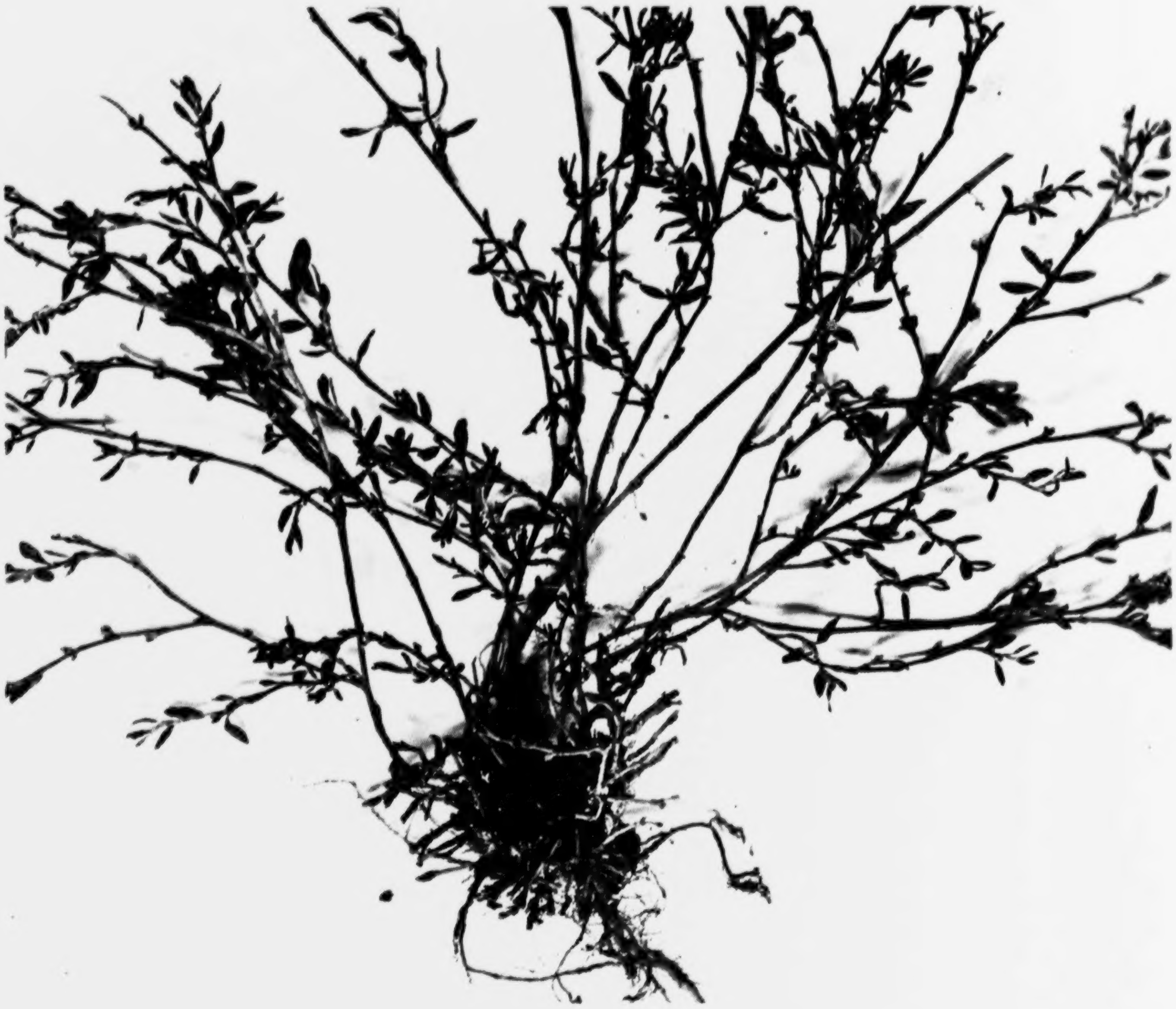


Ground Ivy (Nepeta hederacea)

This weed is also called gill-over-the-ground and creeping Charlie. It is a low growing perennial weed which reproduces by seeds and by stems which root on contact with the soil. Its creeping habit of growth crowds out desirable lawn grasses.

1. The leaves are opposite, rounded, scallop-toothed on the edges, hairy, and on long slender petioles.
2. The stems have four flat sides. A cross-section of a stem appears square in shape. The stems are slender, 15 to 20 inches long, and from roots at the nodes on contact with the soil.
3. The flowers are small, bluish-purple, and borne in small clusters at the axils of the leaves.
4. Ground ivy blooms from May to August.

Control: This weed is very difficult to control after it has a good start. Rake the plants loose and spray with Dicamba in the early spring. Repeat the application until the weed is eradicated.

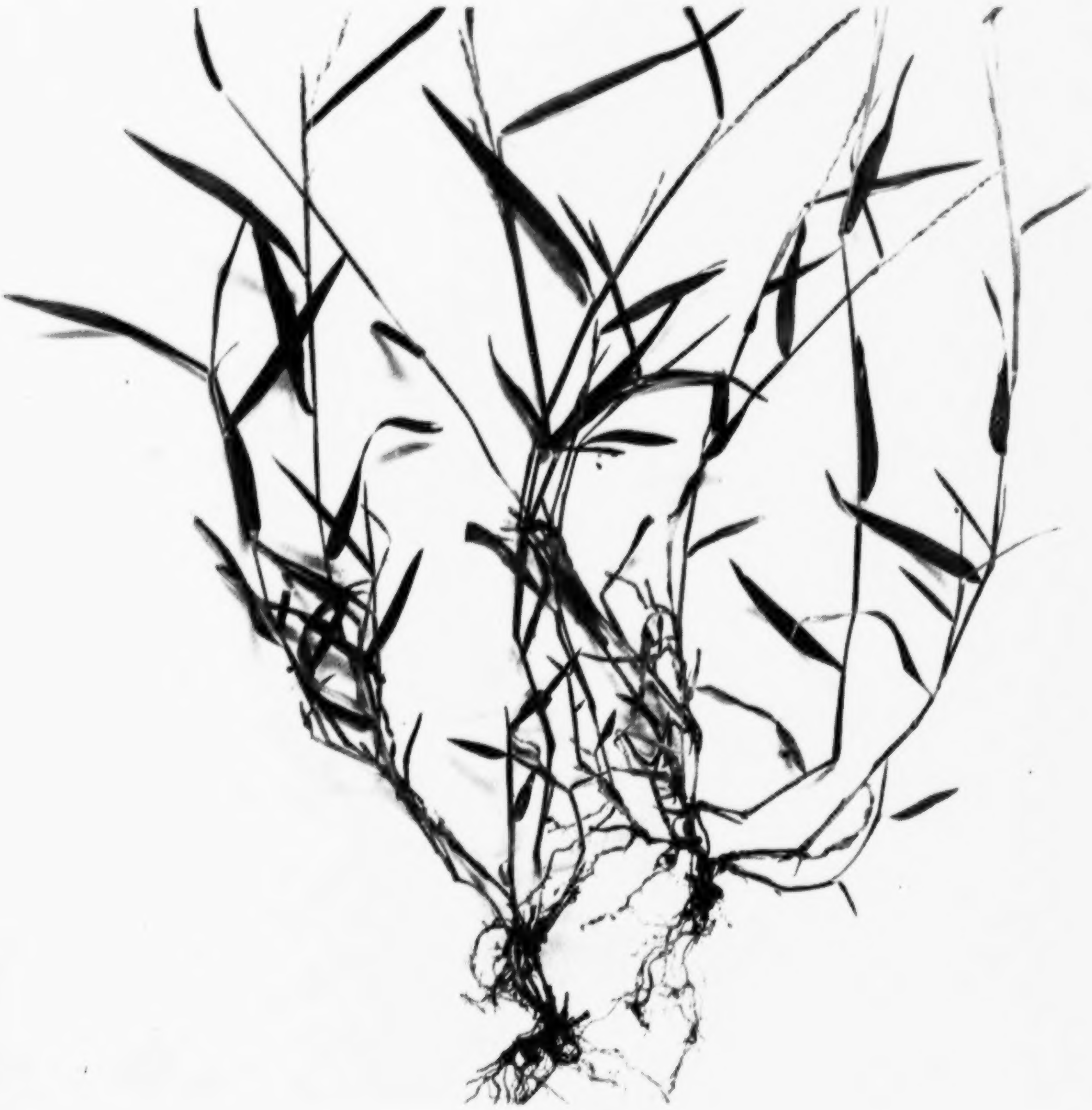


Knotweed (Polygonum aviculare)

Knotweed is an annual plant. It reproduces by seeds. It is found in hard-trampled, compacted areas in lawns, paths, playgrounds, and athletic fields.

1. The leaves are small, oblong, narrow at the base, pointed at the tip, smooth, and bluish-green in color.
2. The stems are bluish-green, very wiry, extend 4 to 12 inches in all directions, and form a dense mat. Each node is covered with a thin papery sheath.
3. Knotweed has a tap root from which the stems grow.

Control: Single plants are easily removed by pulling. Large areas of infestation may be killed with Dicamba or Mecoprop applied in late spring to mid-summer. An application of 2,4-D during early spring when the weeds are young (two- to three-leaf stage) is effective.

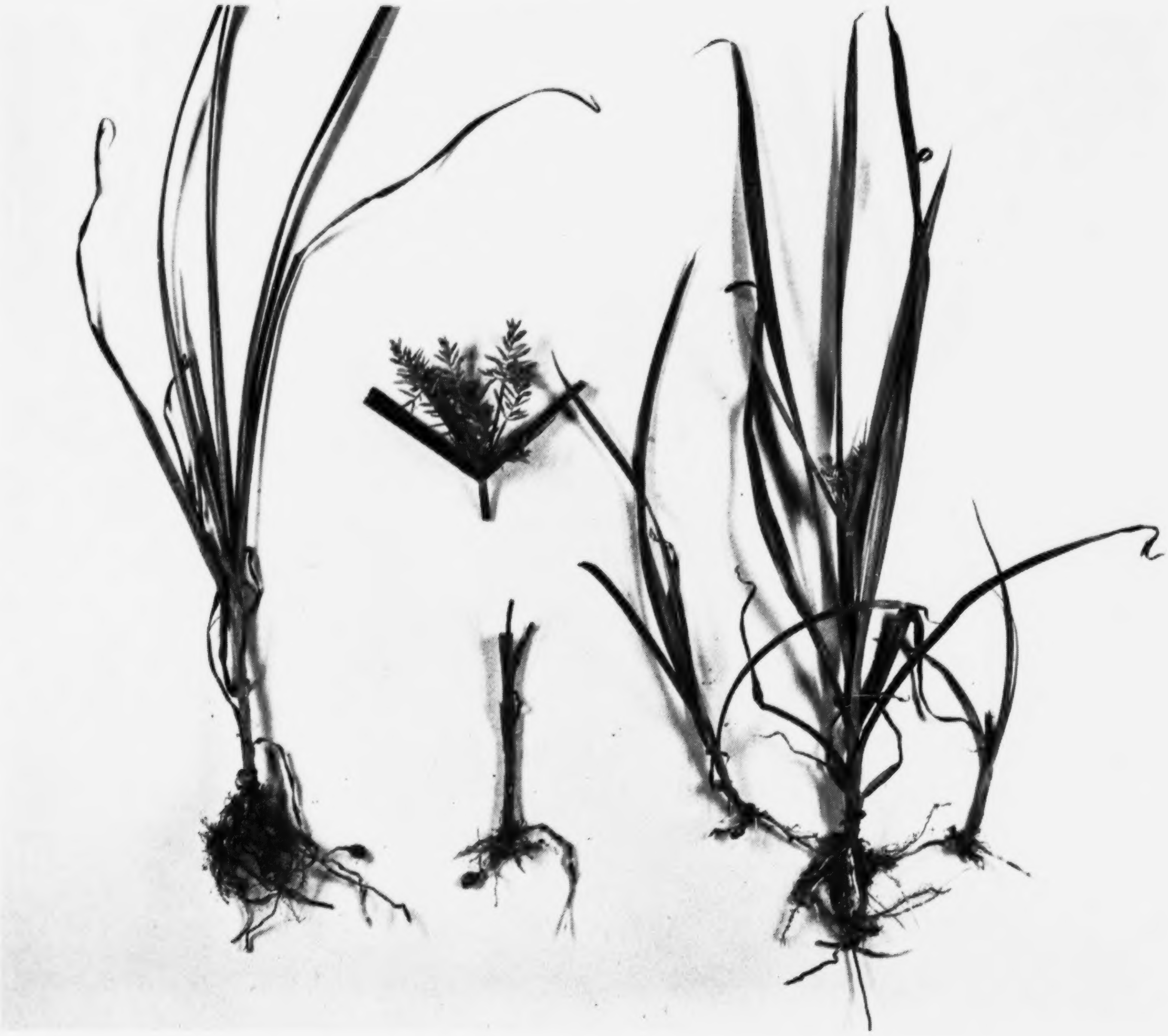


Nimblewill (Muhlenbergia, several species)

Nimblewill is a hardy perennial often confused with crabgrass. This plant reproduces by seed and many fine stolons. One plant may form a dense patch one foot in diameter.

1. The leaves are short, narrow, flat, and pointed.
2. The stems are very slender, spreading, and branching. They recline at the base and root where the lower nodes touch the soil.
3. The seedhead is fine, borne singly, and slender. It is 2 to 6 inches long and appears in September.

Control: The plants are easily pulled. If chemical treatment is desired, spray with Dalapon which will destroy all grasses. Reseed the area after 30 days.

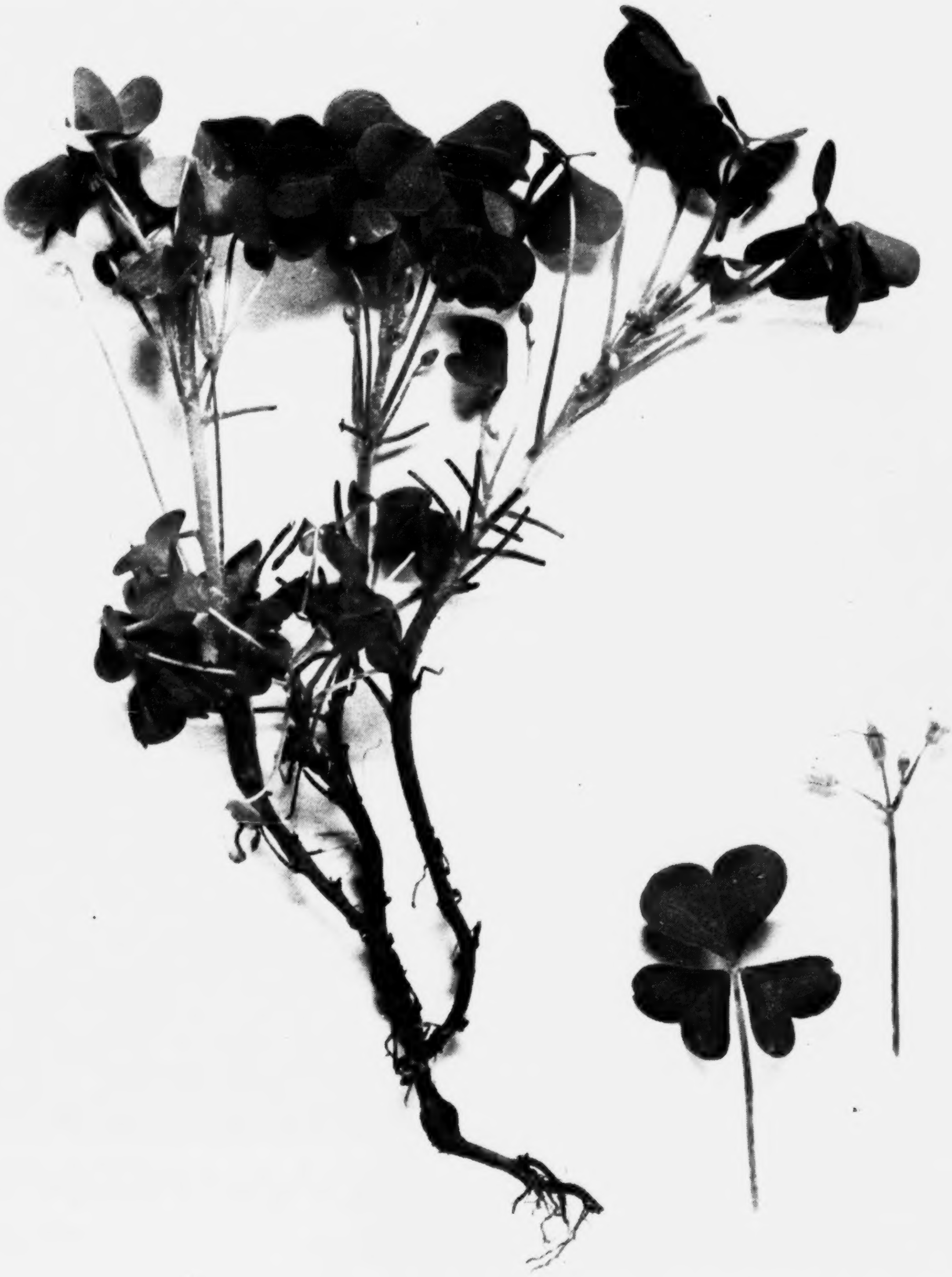


Nutgrass (Cyperus rotundus)

Nutgrass is a sedge rather than a grass. It is a perennial that spreads by underground stems. These underground stems have tubers, or "nuts," that develop into new plants. It is especially invasive in poorly drained soils.

1. The leaves are stiff and coarse.
2. The leaves are yellowish-green.
3. Stems of seed stalks are triangular in cross section.

Control: Small areas - hand removal; large areas - cultivate for full season to destroy the rootstalks and developing plants, or combine 2,4-D and disodium methyl arsonate and apply in late summer for several successive years.

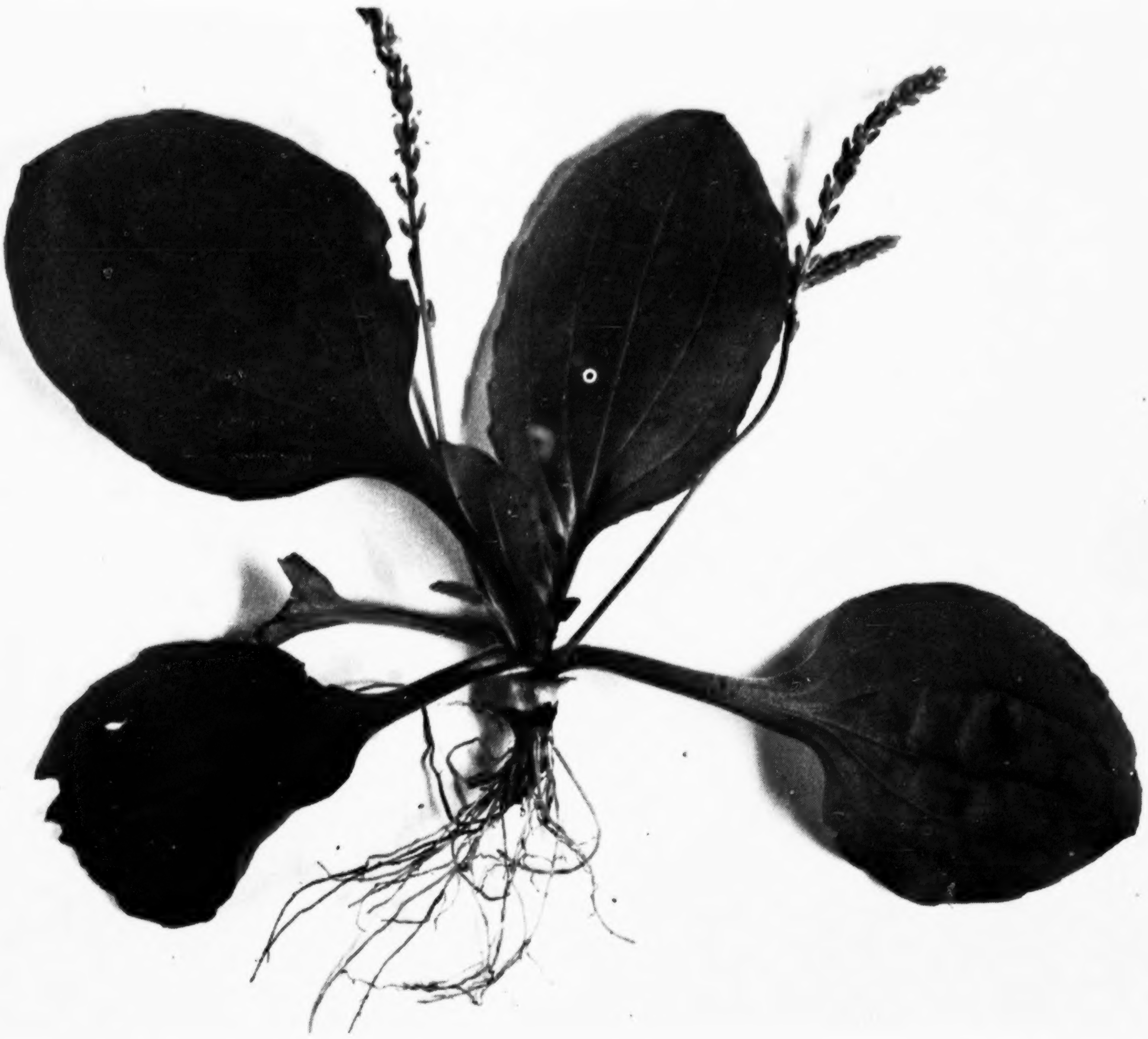


Oxalis (*Oxalis stricta*)

Oxalis is a perennial weed.

1. The leaves are pale green with a clover-like arrangement. The leaves are heart-shaped and have a sour taste.
2. The stems grow along the ground but usually do not root.
3. The plant produces many seeds.
4. It has bright yellow flowers with five petals.

Control: There is no selective chemical control.

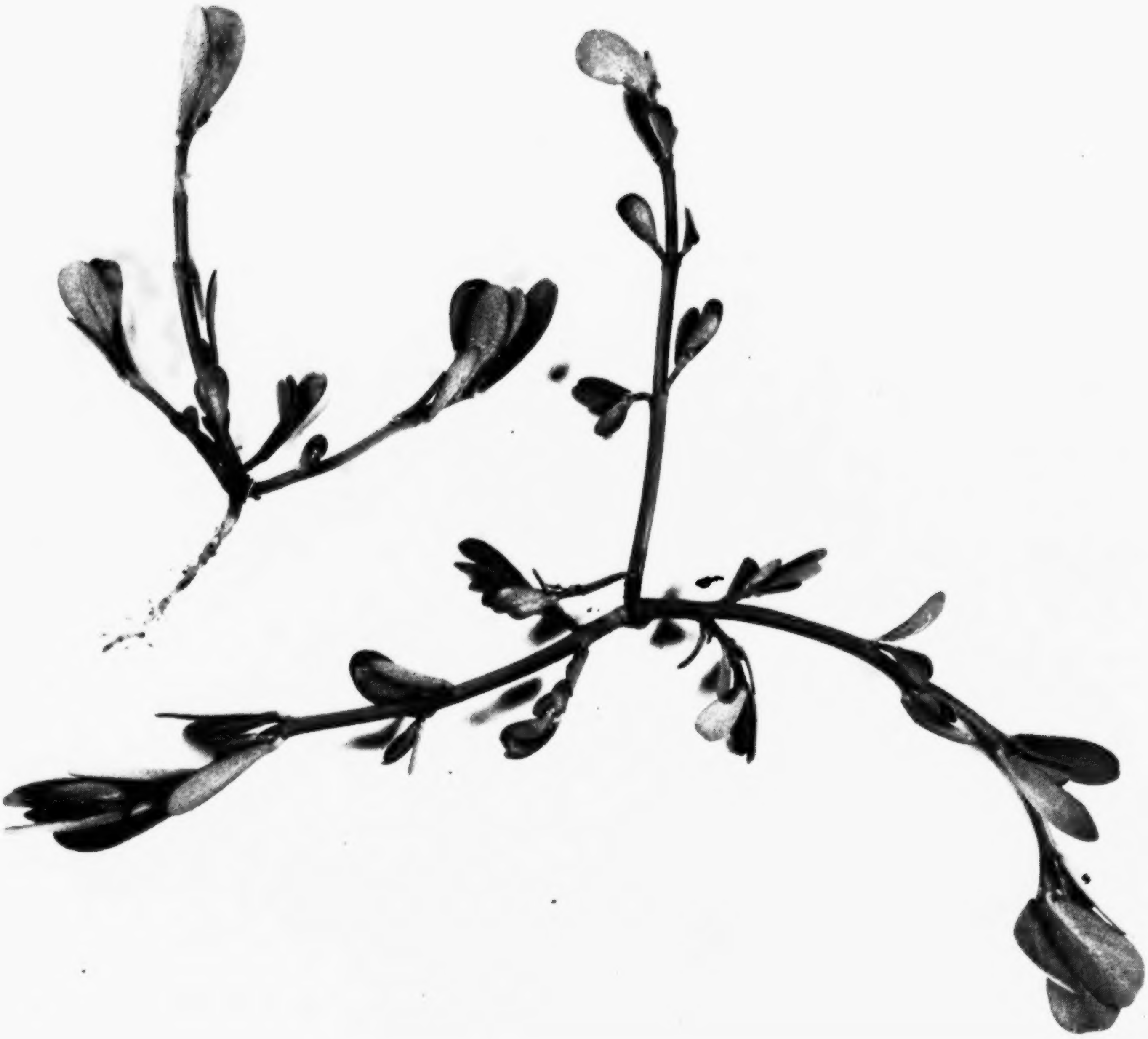


Blackseed Plantain (Plantago rugeli)

Blackseed plantain is a perennial weed which grows in a rosette. It is commonly called Broadleaf plantain. Broadleaf is a plantain very similar in appearance.

1. The leaves are large, oval-shaped, and shiny green.
2. The plant has a pencil-like seedhead which develops from July to September.
3. The stem is green and may grow as high as 12 inches.

Control: Plantain may be controlled by applying 2,4-D when the plant is actively growing. Usually early spring or fall applications are best.

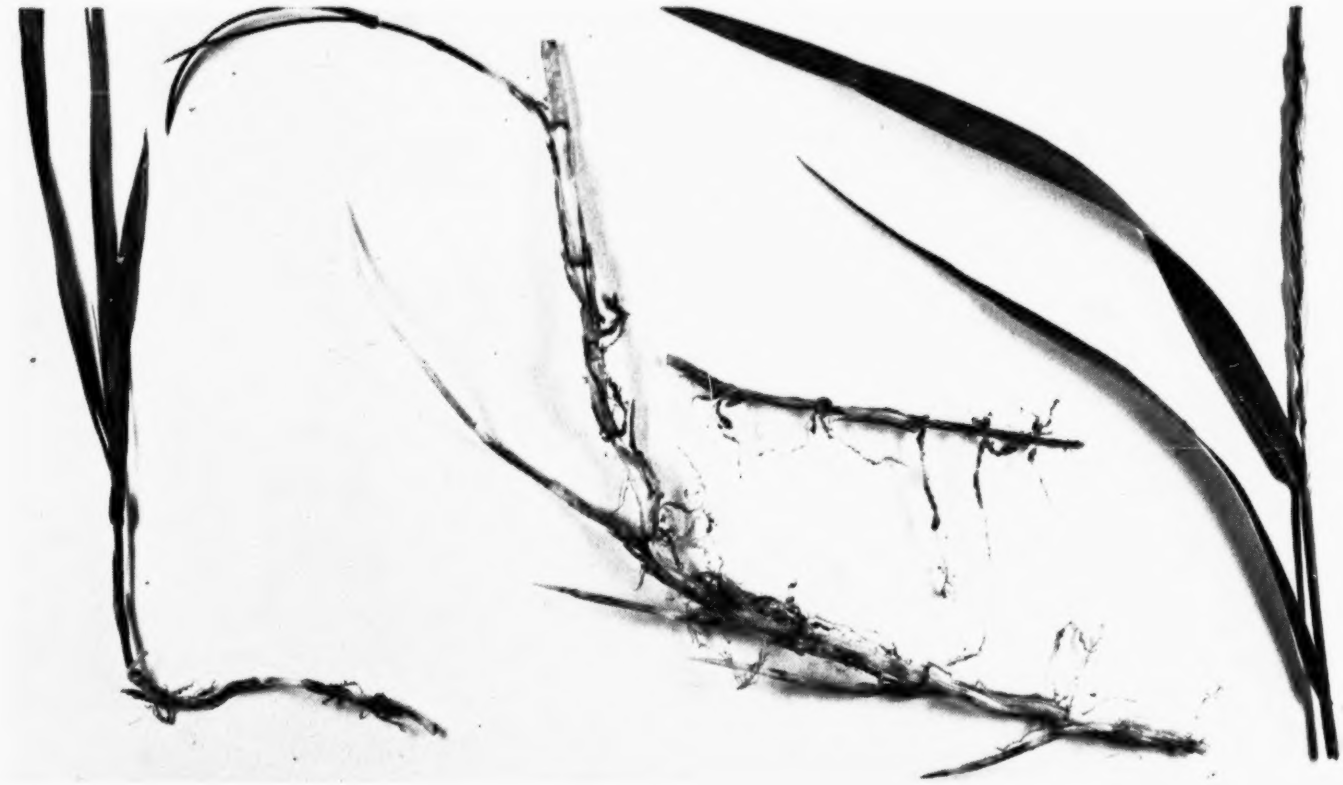


Purslane (Portulaca oleracea)

Purslane is an annual that germinates in warm spring weather. It has a central crown with wide-spreading, flat, stems. It is a problem in new seedings and in bare spots. It grows most rapidly in hot weather.

1. Stems are coarse, fleshy, and reddish.
2. Leaves are rounded, fleshy, and clustered near the stem ends.
3. Tiny yellow flowers are formed in the leaf clusters.

Control: Apply 2,4-D in the seedling stage in late spring; fall sowing of grasses allows rapid grass growth when purslane does not germinate. It does not compete successfully with vigorous, mature grass.

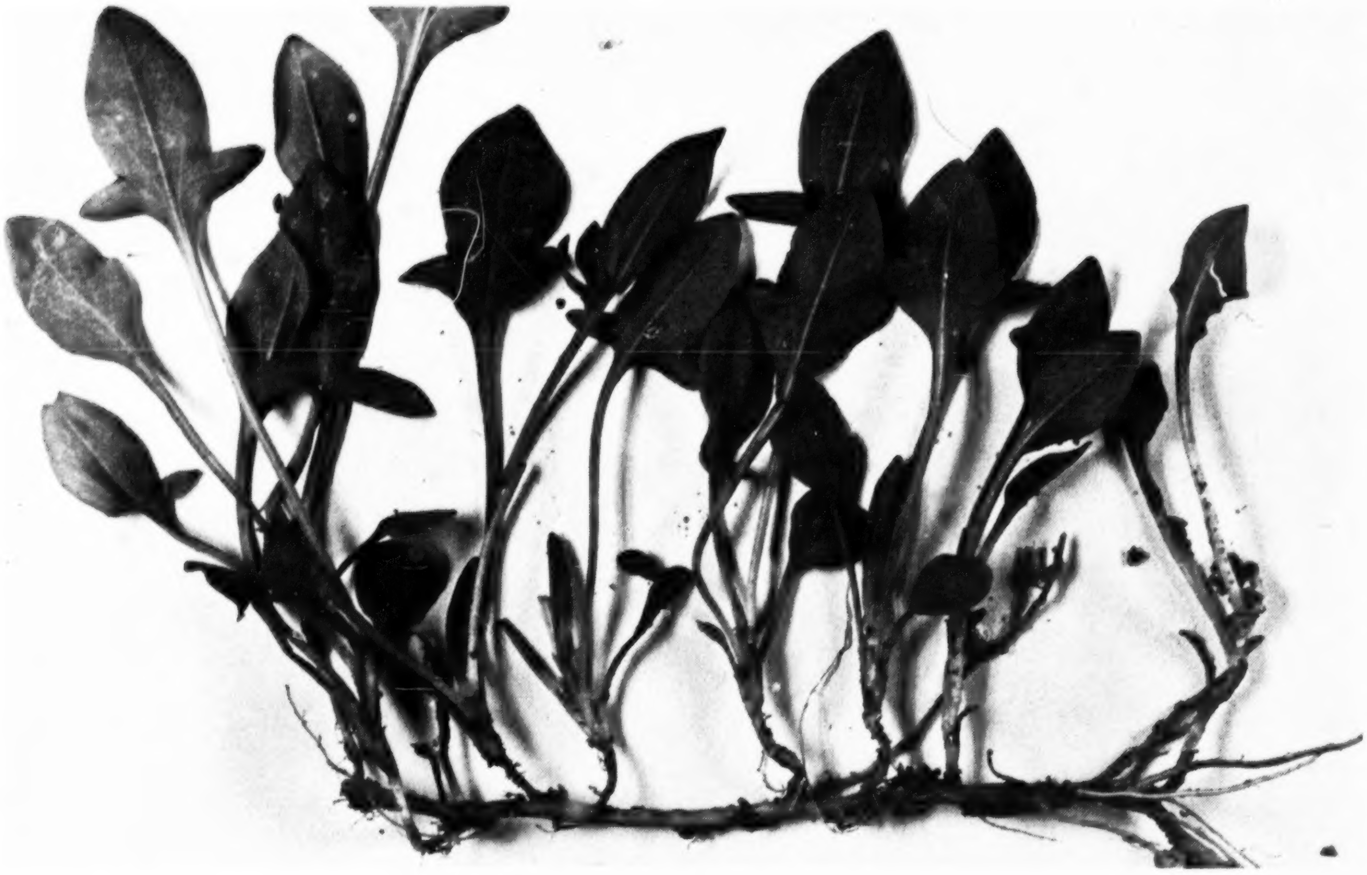


Quackgrass (Agropyron repens)

In early growth, quackgrass resembles other lawn grasses. After establishment, it becomes coarse and crowds out desirable grasses. It is a perennial reproducing by seeds and underground root stems.

1. Quackgrass has an elaborate system of underground creeping rhizomes (stems) that produce new plants. The ends of the rhizomes are hard and sharp.
2. The leaf blades have ligules which are more pronounced when the plant is growing.
3. The leaf blades are narrow, rough above, and smooth beneath.
4. The sheaths on the lower part of the plant are pubescent (hairy) while the sheaths on the upper part are glabrous (smooth).
5. The spikelets are in two opposite rows with the broad side of the spikelet turned toward the axis forming a single terminal spike.

Control: Spray with Dalapon to destroy all grasses. Temporary soil sterilization will result for 30 to 40 days. Reseeding will be necessary after this period. Methyl bromide may be used only by an experienced operator to kill all vegetation. The treated area may be reseeded after 5 days with desirable grass species.

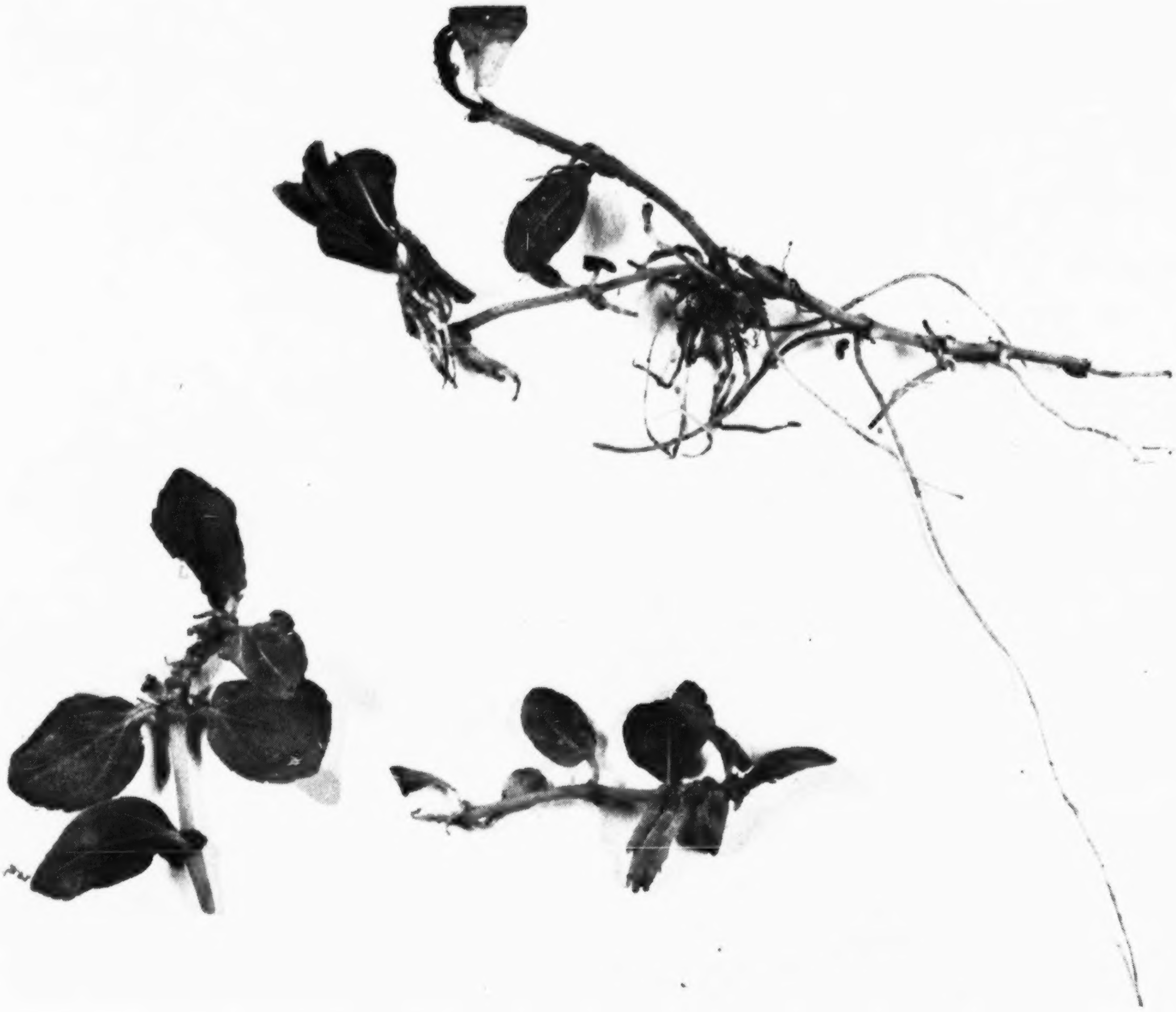


Sorrel (Rumex acetosella)

Sheep sorrel is a creeping perennial that spreads by runners just below the surface of the soil. Sorrel will not compete with desirable grasses which are well established and vigorously growing.

1. The leaves are found mostly at the base of the plant. They are arrow-shaped with two large protruding lobes at the base.
2. The flowers are greenish-red to maroon in color.
3. The glossy seeds are three-angled, reddish-brown, and produced in abundance in branched heads borne on upright seed stalks.
4. The plant is adapted to dry locations and is very tolerant to high acidity and low fertility.
5. New plants develop at the nodes on runners.

Control: This weed is relatively difficult to control. Chemical treatments should be preceded by adequate applications of lime and fertilizer. Dicamba may be used as a spray any time during the growing season. Keep the application outside the drip line of trees and ornamentals.

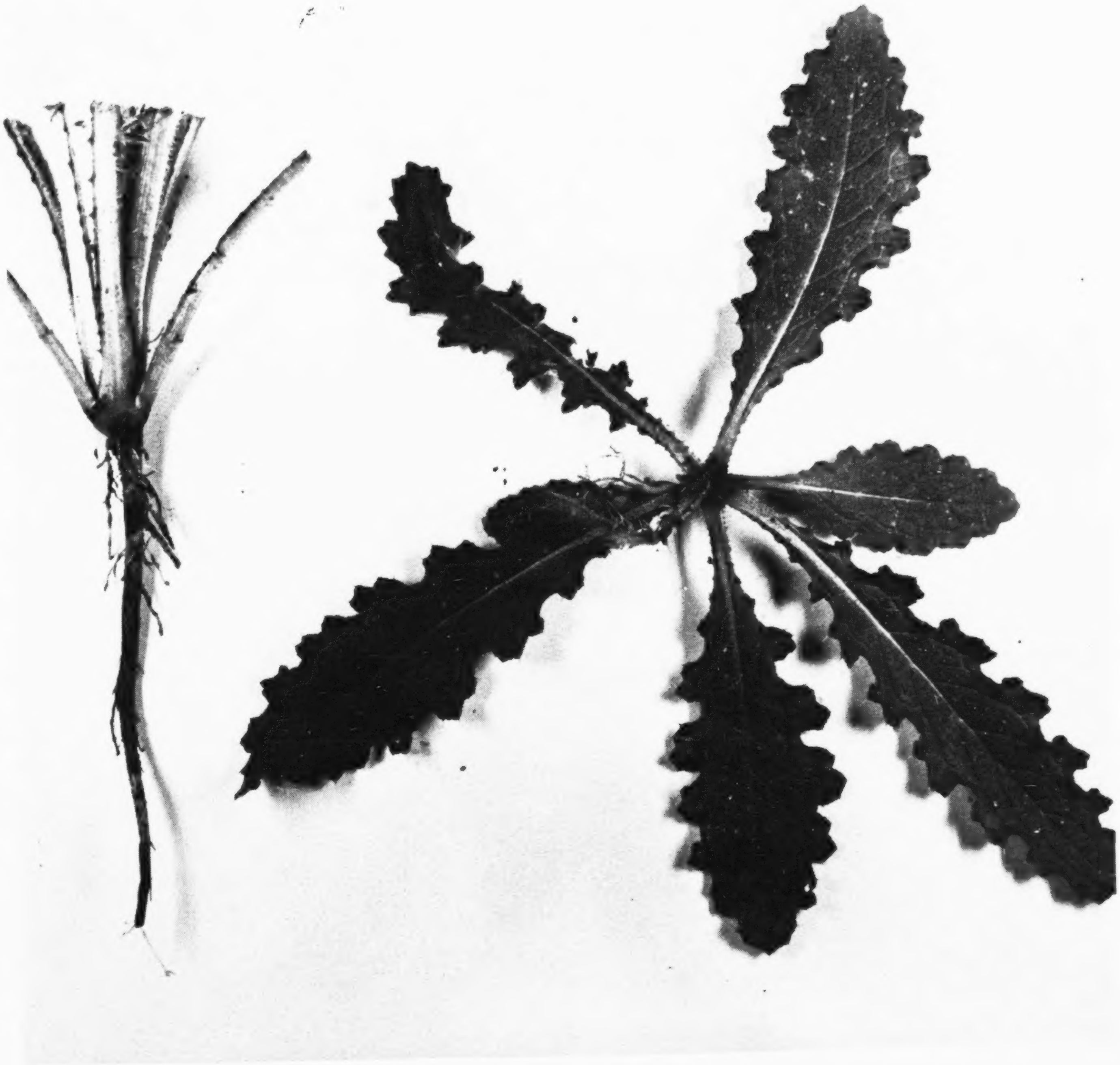


Speedwell (*Veronica* species)

Several speedwells are troublesome weeds in lawns. All are perennials with prostrate stems that root readily at the nodes. They also produce seeds abundantly.

1. Stems are prostrate, but turn up at the ends.
2. Leaves on prostrate stems are opposite and egg-shaped.
3. Leaves on upright stems are alternate and lance-shaped.
4. Flowers of one species are small, star-shaped and light blue; those of another species are larger and darker blue.

Control: A combination of 2,4-D and Banvel D is effective against certain species of *Veronica*. If this does not give control, hand removal is another alternative, or if large areas are involved, fumigate with methyl bromide to kill all vegetation and reseed 5 days later.

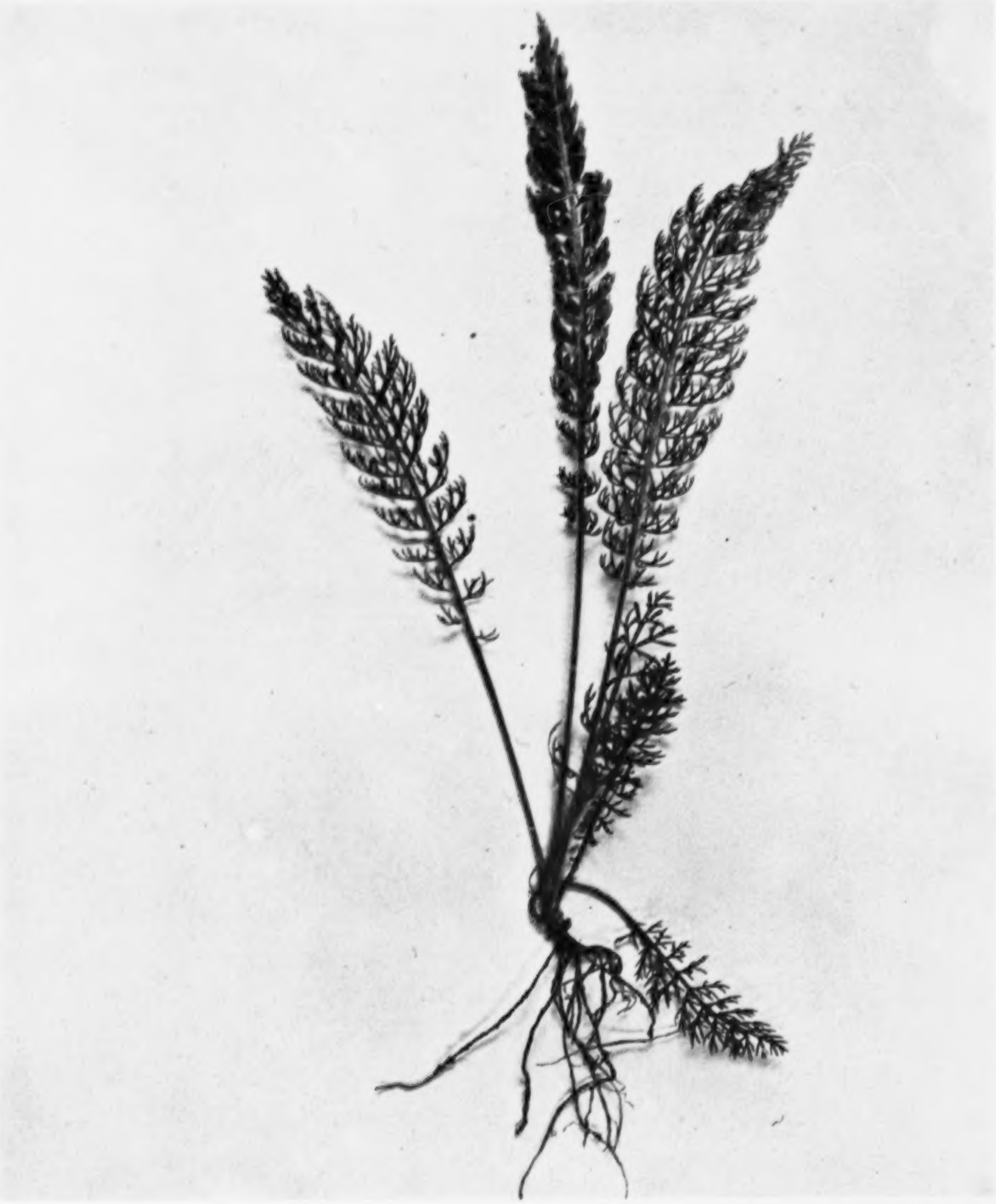


Bullthistle (Cirsium lanceolatum)

Bullthistle forms a single crown. It is a biennial, forming a rosette the first season and a flower stalk the following summer. It is seldom a problem in vigorous mature grass. Mowing removes the developing flower stalks.

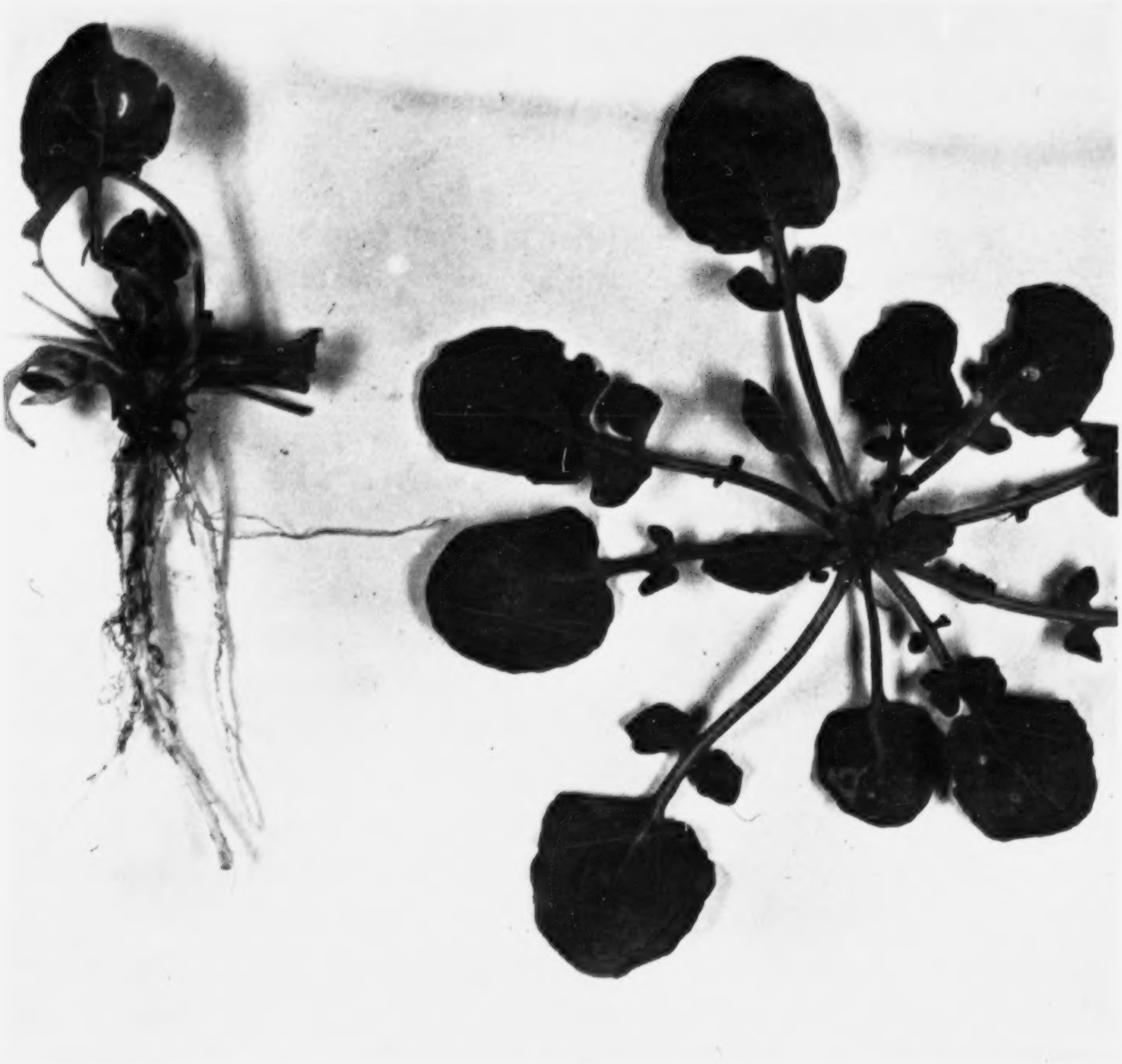
1. Leaves are broad, indented, and covered with sharp spines.
2. Growth habit is a tight rosette.

Control: Hand removal for small areas; 2,4-D applied at any time is effective.



Yarrow (Archillea millefolium)

Yarrow is a perennial, low-growing weed often found in poor lawns. Many of the branches root at the joints and form a dense mat. Repeated applications of 2,4-D may provide some control. For complete control remove the plant by hand.



Yellow Rocket (Barbarea vulgaris)

Yellow Rocket is a perennial usually found in new or poorly established turfs.

1. The leaves are irregularly shaped with large glossy terminal lobes.
2. Left unmowed, the plant will produce an upright stem with yellow flowers at the top.

Control: Yellow rocket may be controlled with an application of 2,4-D in spring or fall.

Turfgrass Diseases

Below are nine diseases which may attack or invade lawns. Most may be prevented or controlled. The prevention and control recommendations listed are from the 1968 Recommended Fungicides and Nematocides, The Pennsylvania State University, College of Agriculture, Extension Service, University Park, Pennsylvania. Control measure recommendations change from one year to the next, so, it is advisable to obtain current recommendations before making applications.

Rates are for 1000 square feet of turf area. The amount of water used in mixing the spray varies. One to five gallons of spray per 1000 sq.ft. are recommended. Per-acre rates may be calculated by multiplying the listed rate by 43.

HELMINTHOSPORIUM LEAFSPOT (*Helminthosphorium vagans*) is commonly called "leafspot" or (in its more advanced stages) "melting out." In early stages, it causes small circular spots on the leaves of turfgrasses. The first symptoms usually occur in the spring. If leafspot is not controlled, it may reoccur and cause serious damage during the summer. There is no control for the advanced stage of this disease. In the advanced stage, the turf appears to be suffering from drought. *Control*: Grass should be mowed to a height of 2 inches. Stimulation with nitrogen fertilizer should be avoided, especially in the spring. Clippings should be removed. *Spray*: Dyrene, 50 percent WP, 4 to 5 ounces; or Dithane M-45, 80 percent WP (Fore), 4 ounces; or Manzate D, 80 percent WP, 4 ounces; or Dithane M-22 Special, 80 percent WP, 4 ounces; or Tersan OM, 5 to 8 ounces; or Thimer, 4 to 6 ounces; or Daconil 2787, 6 ounces.

RUST (*Puccinia* or *Uromyces* species) appears as reddish beads on leaf and stem. It always begins at the tip of the leaf blade and works down the stem. If the grass has been well fertilized and is growing rapidly, frequent mowing may cut off the diseased portions of the leaf. Rust spores fall on uninfected leaves if clippings are not removed. One method of identifying rust is to rub the suspected blade of grass between the thumb and forefinger. If the red spores collect on the thumb and finger, rust is present. *Control*: Proper mowing, watering, and fertilization practices. *Spray*: Acti-dione Thiram, 4 ounces; or Zineb, 75 percent WP, 2 ounces.

PYTHIUM BLIGHT (Pythium ultimum, or P. aphanidermatum) is a disease which is most severe on bentgrasses. It usually occurs when humidity is over 70 percent and temperature is above 70° F. Pythium blight normally occurs in streaks along drainage channels. The infected areas look like an oil spot on a paper towel. The grass blades appear slimy; they mat together, wither, become reddish brown, and lie flat. Within 24 hours they may be dead. Control: Avoid overwatering, especially in warm weather. Spray: Zineb, 75 percent WP, 2 ounces; or Dexon (turf form), 3 ounces.

DOLLAR SPOT (Sclerotinia homoeocarpa) is called "dollar spot" because the turf normally dies out in spots about the size of a silver dollar. It is particularly troublesome on the bentgrass of golf greens. The spots may overlap and become larger. They seldom form a definite pattern on the more common lawn grasses. Dollar spot may be mistaken for drought injury, but it can usually be identified by close observation. It appears on the grass leaves as a white spot with brown margins. As the disease progresses, the part of the leaf above the white spot will die. The part of the leaf below the spot will remain alive. Dollar spot is more severe where there is thatch. It is most likely to appear during late spring and early fall, especially when the days are warm and the nights are cool. Control: Spray; Dyrene, 50 percent WP, 4 to 5 ounces; or Tersan OM, 5 ounces; or Dithane M-45, 80 percent WP, (Fore), 4 ounces; or Manzate D, 80 percent WP, 4 ounces; or Dithane M-22 Special, 80 percent WP, 4 ounces; or Thimer, 3 ounces; or Cadmium fungicides (i.e. Cadminate, Caddy, Puraturf 177, etc.) at manufacturer's directions; or Acti-dione Thiram, 3 to 4 ounces; Thiram 75, 3 to 6 ounces; Daconil 2787, 75 percent WP, 4 to 6 ounces.

FAIRY RING (Mushroom fungi) is caused by mushroom-type fungi. The fungi do not live on the grass. They live on the organic matter in the soil. Pieces of wood which have decayed below the soil surface for several years are most often the place where the organisms begin to grow. The fungi grow in wide circular patterns. The diameters of the circles range from several inches to 50 or more feet. The greener growth within the circle is caused by the nitrogen released by the decomposition of the mycelium produced by the fungi. Mushrooms often grow outside the ring of dark green grass. If the turf area behind the mycelium is watered well, the turf will not be as subject to damage. Control: Chemical control is difficult and may not be practical. Proper fertilization helps hide the rings.

BROWN PATCH (*Rhizoctonia solani*) is most prevalent in hot, humid weather. It occurs primarily on bentgrasses. It is very damaging to the soft succulent growth which follows nitrogen applications, appearing as irregular brown patches from a few inches to several feet in diameter. A narrow, smoke-covered ring borders the diseased area in bentgrasses. A severe case will kill the plant. *Control*: If cool dry weather occurs before advanced stages of crown injury, the disease will disappear and the turf will recover in 2 to 3 weeks. Avoid excessive nitrogen fertilization. Water lawn early in the day. *Spray*: Tersan OM, 5 ounces; or Thimer, 3 ounces; or Dithane M-45, 80 percent WP, 4 ounces (Fore); or Dithane M-22 Special, 80 percent WP, 4 ounces; or Dyrene, 50 percent WP, 4 to 5 ounces; or Acti-dione Thiram, 3 to 4 ounces; or Manzate D 80 percent WP, 4 ounces.

SLIME MOLDS (*Myxomycete* species) attack all grass species. They occur during wet weather. The grass appears to have a white, yellow, bluish-gray, or black hue. The mold on the grass is slimy. The organisms causing the slime do not damage the grass, for they are non-parasitic. But they cause damage by shading and smothering the grass. *Control*: Affected grass should be washed with a hose or brushed with a broom. The molds will dry up when the weather becomes drier. When persistent, use Zineb, 65 percent WP, 2 ounces (one-half cup) in 2 gallons of water per 1000 square feet of turf area.

SNOW MOLDS (*Typhula itoana* and *Fusarium nivale*) often occur in places where snow covers the turf for long periods of time. However, the turf does not need to be covered with snow previous to the appearance of the molds. Snow molds may attack turf areas when conditions are wet and temperatures fall below 65° F. Snow molds appear as grayish-white, cottony growth on the leaves which later turn brown, die, and mat together. The diseased area may be 1 to 12 inches in diameter or much larger. It may be caused by either of two organisms, but the control for either is the same. *Control*: Keep the lawn properly mowed and do not apply large amounts of nitrogen fertilizers in late fall. Rake or brush the matted turf as the snow melts. For prevention, spray during warm periods in January and February, with either Calomel - Corrosive sublimate (Calo-clor, Fungchex, etc.), 2 to 3 ounces, or Phenylmercury according to manufacturer's directions; or Tersan OM, 6 ounces; or Dyrene, 50 percent WP, 6 ounces.

POWDERY MILDEW (Erysiphe graminis) occurs on some grass species grown in shady areas. Merion bluegrass is often infected with this disease. It appears on the leaves and makes the turf look as though it has been dusted with flour. Control: Spray with Karathane, 25 percent WP, 1/4 ounce; or Acti-dione Thiram, 4 ounces.

NEMATODES are small microscopic round worms which live in the soil and feed on the roots of grasses. When the turf is infested with nematodes, it will appear to be suffering from a general lack of vigor. Control: Drench with 3/4 pint of actual Nemagon or Fumazone in 10 to 50 gallons of water per 1000 square feet of turf area followed by an application of one inch of water.

Turfgrass Insects and Suggested Controls[2]

There are a number of insects which damage lawns. The most common are ants, grubs, chinch bugs, and sod webworms. Some insects chew leaves, stems, and roots of lawn grasses. Others suck juices from the plant. In each case the plant is weakened. Gradually the grass weakens, losing its healthy green color. In this condition the turf is susceptible to disease and drought.

ANTS are small insects that burrow in the soil and live in communities. The mounds of soil they build are unsightly and interfere with mowing. They may bite persons who sit on the turf.

GRUBS are white fleshy worm-like larvae with dark-brown heads and legs. They cause circular dead patches of grass that are easily lifted. They curl into a curved position when uncovered in the soil. They are the larvae of Japanese beetles, June beetles, Asiatic garden beetles, and the Oriental beetles. They damage the turf by feeding on the roots of the grass plant.

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[2] Recommendations from College of Agriculture, Extension Service 1968 Recommended Insecticides and Miticides, The Pennsylvania State University, University Park, Pennsylvania

CHINCH BUGS suck plant juices from the stems of turf grasses and cause brown spots in the lawn. The spots grow larger as the insect infestation spreads. The bugs may be found on the crowns of plants near the edges of the injured areas. The full-grown adult has a black body with white wings spotted with black and folded along the back. Immature chinch bugs are pink and wingless. Otherwise, they look like the adult.

SOD WEBWORMS may produce brown patches in the lawn. Robins and starlings feed on these insects. Sod webworms are the caterpillar stages of several moths. They may be dingy yellow, gray, or shades of brown. They are about 5/8 of an inch long when fully grown. They injure the turf by feeding on the stems and leaves of the grass plant.

TURF INSECT AND ANIMAL CONTROL "1968-69"*

Pests--All recommended amounts of emulsifiable concentrate (E), and wettable powder (WP) are for mixing in 2 to 3 gallons of water to be applied to 100 sq.ft. of lawn area. Amounts of dusts and granules are based on the 100 sq.ft. of lawn area. When applicable, recommended rates are also given on an acre rate in pounds actual per acre. Do not permit pets or children on sprayed grass until spray is completely dried. Most treatments can be made with a sprinkling can.

Ants	Chlordane 5% dusts and granules 4 oz, 10% dust and granules 2 oz, 40% WP 2 tbsp, 45% E 1 tbsp; 75% 1½ tsp (5 lb actual per acre); diazinon 25% E 2 tbsp, AG 500 1 tbsp (6.5 lb actual per acre). Spot treat ant hills and nests with double the recommended amounts. Blow dust into tunnels.
Chinch Bugs	Diazinon 25% E 2 tbsp, AG 500 1 tbsp, 2% granules ½ lb (6.5 lb actual per acre); carbaryl 50% WP 3 tbsp, 5% dust and granules ½ lb (10 lb actual per acre); aspon 5% G 6 oz (7 lb actual per acre).
Clover Mites	Chlorobenzilate 25% WP 6 tbsp; dicofol (Kelthane) 35% WP 1 tbsp, 18.5% WP 2 tbsp; diazinon 25% E 2 tbsp, AG 500 1 tbsp. Direct spray application to the foundation and to a band 5 feet wide around the periphery of the house. Double the concentration for foundation treatments only. Repeat application if necessary. Spray during April or in the fall.
Earwigs	Diazinon 25% E 2 tbsp; AG 500 1 tbsp; carbaryl 50% WP 3 tbsp; chlordane 45% E 1 tbsp, 40% WP 2 tbsp; lindane 25% WP 4 tbsp. Earwigs do not injure turf.
Grubs	Chlordane 5% dust and granules ½ lb, 10% dust and granules ½ lb, 40% WP 4 tbsp, 45% E 2 tbsp, 75% E 1 tbsp (10 lb actual per acre). Water into the soil immediately after application. This rate will give a minimum of 5 years control.
Leaf-hoppers	Methoxychlor 50% WP 3 tbsp; malathion 25% WP 6 tbsp; diazinon 25% E 2 tbsp; lindane 25% WP 3 tbsp.
Milli-pedes	Carbaryl 50% WP 4 tbsp; diazinon 25% E 3 tbsp; ethion 25% WP 4 tbsp. Millipedes do not injure turf. Treat a band 10 feet wide around the foundation.
Moles	Grub proof. Use properly set traps. Poisoned baits.
Sod Webworms	Carbaryl 50% WP 3 tbspl diazinon 25% E 2 tbsp; chlordane 40% WP 4 tbsp, 45% E 2 tbsp, 75% E 1 tbsp.
Wasps	Treat nests in the evening when wasps are least active. The following rates are for mixing in 1 gal of water; 1 gal of spray mixture will treat 2 to 3 ground nests. Chlordane 40% WP 1¼ cups, 42% E 10 tbsp; methoxychlor 25% WP 3 cups; lindane 25% WP 8 tbsp, 20% E 5 tbsp; DDT 50% WP 2 cups.

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*1968 Recommended Insecticides and Miticides - Selection - Application - Safety. p. 63. Extension Service, College of Agriculture, The Pennsylvania State University, University Park, Pennsylvania.

USING PESTICIDES

Safety Guides

1. Most pesticide recommendations are based on the weight of the active ingredient. The weight of the active ingredient should be used when calculating the proper amount of the pesticide to apply.
2. Read the entire label before mixing or diluting chemicals and follow safety precautions.
3. Avoid drift. Applications should be made when the weather is calm. Early morning or evening is the best time to apply pesticides.
4. Avoid inhaling pesticides. Never eat or smoke while spraying or dusting. Avoid spilling pesticide on skin or clothing. Wash immediately if spilling occurs.
5. Store pesticides only in original containers. Never put pesticides in food or drink containers.
6. Store all chemicals out of reach of children and livestock, and away from feed supplies, in a separate compartment which can be locked. Keep a pesticide use record and inventory.
7. Do not dump excess spray materials down the drain, in ponds, streams, or other water sources, or otherwise endanger wildlife.
8. Do not burn cans, containers, or bags which once contained pesticides.
9. Dump excess spray material on gravel areas or other areas where soil sterilization may be desired, such as the base of electrical poles or rights-of-way.
10. Use separate sprayers for insecticides, fungicides, and herbicides.
11. Wash hands and face and change to clean clothing after applying pesticides.
12. If accidental poisoning occurs, contact a physician immediately or local Poison Control Center.

Guides for Maintaining Sprayers and Dusters

1. Do not use hard or sharp instruments for unclogging nozzles. Permanent damage may result.
2. Check all hose connections before spraying or dusting.
3. Begin cleaning after spraying by pumping or flushing at least two changes of clean water through the system.

4. Disassemble the sprayer after operation and thoroughly clean all parts with kerosene and water (except those made of rubber). An old tooth brush may be used to clean the smaller parts.
5. Keep oil away from rubber hoses. Use ammonia water, one quart per 50 gallons of water, for cleaning rubber hoses.
6. Replace worn parts such as washers and nozzle discs when cleaning.
7. Hang sprayers in a cool dry place for storage.

Guides for Applying Sprays and Dusts

1. To prevent spotting, apply dusts when the leaves are dry unless otherwise directed.
2. Read and follow the manufacturer's directions for operating sprayers and dusters.
3. Weigh all dust materials before putting them into a duster.
4. Before spraying with chemicals, conduct a trial run and watch for clogging.
5. Maintain a constant pressure when making a spray application. Keep a close watch on the regulator at all times.
6. Do all mixing in a clean container before pouring it into the sprayer tank. Mix thoroughly.
7. Strain all chemicals before pouring them into a sprayer tank.
8. Keep the sprayer nozzle at a uniform height above the ground. The height above the ground will depend on the type of nozzle. Keep the nozzle moving at all times when spraying.
9. After applying insecticides for controlling above-ground insects, sprinkle lightly with water to wash the chemicals down to the crown of the plant.
10. After applying insecticides for controlling under-ground insects, water the grass thoroughly to wash the insecticide into the soil.
11. Do not apply lime for several weeks after pesticide treatments.

Types of Sprayers Used on Lawns

The garden-hose sprayer is one of the simplest sprayers to operate. It is an inexpensive attachment that screws on the end of an ordinary garden hose. However, it is difficult to make uniform applications of pesticides with it. The hose pressure may not be high enough to produce a fine spray.

Hose lengths can also be a limiting factor when making an application. This piece of equipment is best suited for emergencies and very small lawns. It is inadequate as basic equipment for a spray program for large turf areas.

The knapsack sprayer is operated by hand. It has a 2- to 6-gallon spray tank which straps to the back of the person applying the pesticide. It has a 4- to 5-foot hose equipped with a spray nozzle. The biggest advantage of the sprayer is the uniform spray pressure which it provides. The parts of the knapsack sprayer are subject to wear. The tanks tend to corrode and rust. It is difficult to keep spray liquids agitated for uniform application. This sprayer is the most commonly used and the most often recommended for average-size home lawns.

Power sprayers are sold in various sizes, shapes, and capacities. Some are of the wheelbarrow type, some are mounted on tractors, and others are mounted on tractor-drawn trailers. The sprayers are relatively expensive and are not practical for use on small home lawns. They are commonly used for large lawns, industrial landscapes, estates, and institutions.

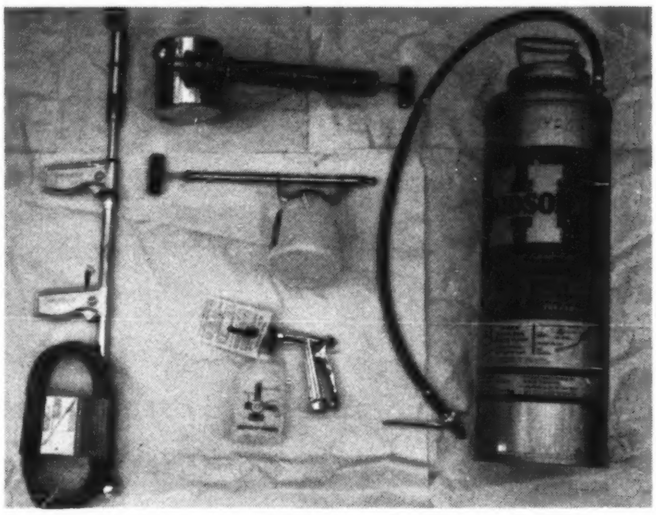


Figure 5. Sprayers

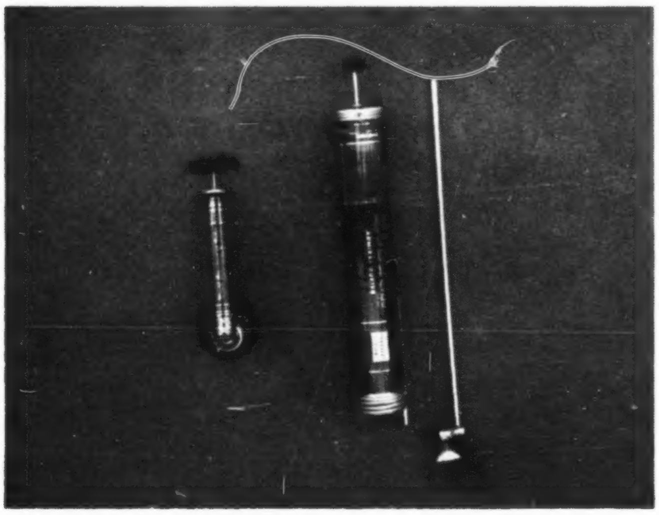
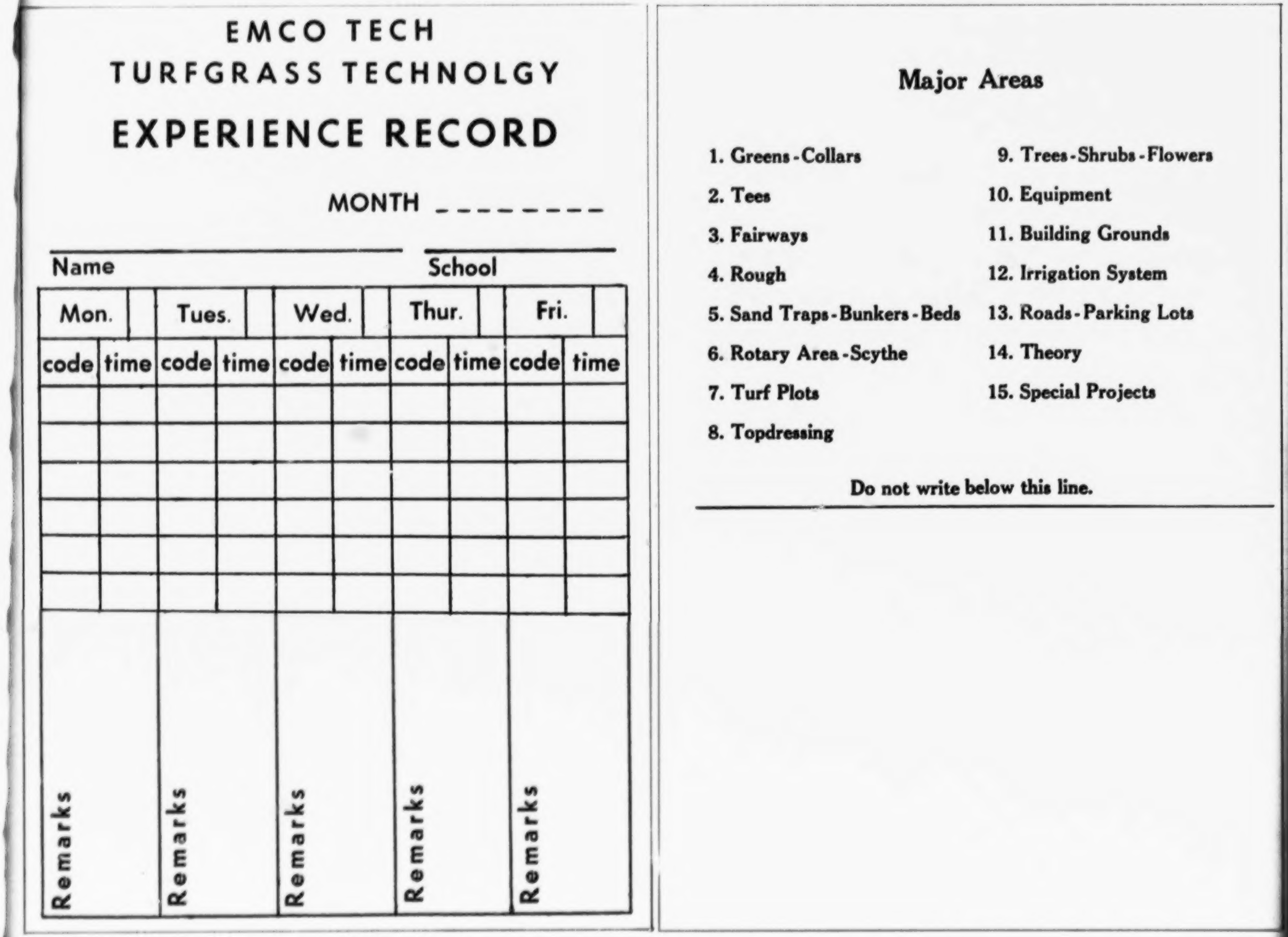


Figure 6. Dusters

Test

1. What factors determine the value of a fertilizer?
2. How do organic fertilizers differ from inorganic fertilizers?
3. What information is supplied in a soil-test laboratory report?
4. Why are lime applications so important for acid soils?
5. When is the best time to correct soil acidity with applications of lime? How should the lime be applied?
6. When is the proper time to fertilize lawns?
7. What is the best method of applying lawn fertilizers?
8. What is the correct mowing height for most lawn-grass mixtures?
9. What conditions determine when a home lawn should be watered?
10. Name the most troublesome weeds, insects, rodents, and pests found in home lawns. Name a good control measure for each.
11. Why shouldn't turf be mowed when it is wet?
12. Define aeration, thatch, top-dressing, and grain.



EMCO TECH
TURFGRASS TECHNOLGY
EXPERIENCE RECORD

MONTH ________

Name ____________ School ____________

Mon.		Tues.		Wed.		Thur.		Fri.	
code	time	code	time	code	time	code	time	code	time
Remarks		Remarks		Remarks		Remarks		Remarks	

Major Areas

1. Greens - Collars
2. Tees
3. Fairways
4. Rough
5. Sand Traps - Bunkers - Beds
6. Rotary Area - Scythe
7. Turf Plots
8. Topdressing
9. Trees - Shrubs - Flowers
10. Equipment
11. Building Grounds
12. Irrigation System
13. Roads - Parking Lots
14. Theory
15. Special Projects

Do not write below this line.

Sample Turfgrass Occupational Experience Record

SUGGESTIONS AND REFERENCES FOR THE TEACHER

Considering the fact that most lawns do not receive even minimum maintenance care, there is much room for improvement in the quality of home lawns. Persons qualified to maintain lawns have good opportunities for employment. Maintenance services which include mowing, fertilizing, edging, and spraying for weeds and diseases for growing in number, especially in the larger cities. Teachers should urge and help interested students develop their own businesses.

Learning Resources

References:

Control Turfgrass Diseases. Reference No. 6.
Lawn Diseases and How to Control Them. Reference No. 14.
Home Lawns. Reference No. 13.
The Lawn Book. Reference No. 22.
Turf Management. Reference No. 27.
Pennsylvania Weeds. Reference No. 17.
What's That Weed? Reference No. 28.

Equipment:

1. Seed flats
2. Magnifying lens (10X power)
3. Single edge razor blades
4. 1-inch corks
5. Soil sampling equipment and supplementary information forms
6. Small fertilizer spreader
7. Rotary mower
8. Reel mower
9. Soil test kit (pH)
10. Spray equipment

Resource people:

1. Golf course superintendent
2. Representative of chemical companies manufacturing herbicides and insecticides
3. University extension specialists

4. Athletic field supervisor
5. Highway maintenance supervisor
6. County agent
7. Turf fieldman

Suggested Student Learning Activities

1. Show your students how to take a representative soil sample [illegible] home lawn. Have each student complete a supplementary information form. Mail the soil sample to the laboratory for analysis. When the test results are returned, the class should note and discuss the recommendations.
2. Compare the costs of fertilizers produced by different companies. Consideration should be given to differences in analysis, composition (organic vs. inorganic), structure (granular vs. coated), brand preference and cost.
3. Students need to learn how to safely operate rotary and reel mowers. The effect of sharp and dull blades should be demonstrated with each type of mower. Use a magnifying lens to inspect and compare the clipped ends of the grass. Discuss the differences. Review the safety features of both types of mowers. Emphasize the consequences of not observing safety rules in the use of rotary power mowers. Ask the students to relate personal experiences. Observe the growth of grass after it has been cut with a reel mower and a rotary mower.
4. Tour several local lawns to observe the effects of (1) proper and improper fertilizations, (2) proper and improper mowing, edging, and watering, and (3) different types of pest damage and control measures.
5. Show the color slide series, "Weed Identification." Students may need to see the series several times. Substitute or add pictures of local weeds that are not in the slide series.
6. Collect and mount or preserve specimens of weeds, insects, and diseases of turf. This can be a class project. Have your students prepare a display for your school exhibit window, using some of the better specimens.

7. Demonstrate how to use the different types of spray equipment for controlling pests on home lawns. Students may bring from home types of equipment not available at the school. Compare the advantage and disadvantages of similar types of equipment. Students should have an opportunity to calibrate and operate the more common type of spray equipment used on home lawns. As a safety precaution, water may be used as a substitute for chemical sprays to teach the proper use of spray equipment. All safety factors should be observed.
8. Have the class determine a current list of effective chemicals for controlling weeds, insects, and diseases. List the chemical, method of preparation, and rate and time of application. The effectiveness of the chemicals may be tested in demonstration plots in the school land laboratory. Ask students to design the test plots and keep records of the tests.
9. Have the class determine the water distribution pattern of several makes and models of home-lawn portable watering devices by the use of empty tin cans (as explained in the section on watering turf).

Suggested Placement Experiences

Arrange the work experience program so as to have students involved in the following activities:

1. Mowing, fertilizing, watering, taking soil samples, and identifying weeds.
2. Keeping records such as time, wages, variable costs, fixed costs, social security, and taxes.
3. Adjusting and maintaining equipment such as aerifiers, fertilizer spreaders, mowers, sprinklers, sweepers, and tractors.
4. Cautiously observing the selection and application of pesticides.
5. Preparing a calendar of activities for the year.

PROBLEM AREA 4

MAINTAINING ATHLETIC FIELDS AND SPECIAL TURF AREAS

Student Learning Objectives

1. To learn the use requirements of athletic fields and special turf areas.
2. To learn how to assess the growth and environmental conditions of athletic fields and special turf areas.
3. To learn how to fertilize, mow, aerate, and irrigate turfs properly.
4. To learn how to control pests effectively.

Key Questions

1. What are the major problems associated with the maintenance of athletic fields and special turf areas?
2. How do maintenance practices on athletic fields differ from such practices on the home lawn? The golf course?
3. Why is aeration particularly important on athletic fields?
4. How do the maintenance practices used on special turf areas differ from those used on the athletic field?

New Words

Pest - a weed, an insect, a disease, or an animal
pH - a symbol indicating the acidity level of the soil
Plugging - removing a small section of turf and replacing it with another
Semi-annual - six months
Semi-dormant - growth retarded but not stopped
Soccer - a form of football
Sodding - removing a large section of turf and replacing it with another

Athletic Fields

Cooperation for Good Turf

Athletic fields require slightly different maintenance practices than residential lawns because they are used seasonally, they have unusually heavy traffic, and they have different grass types. There is a limit to the amount of use that even an excellent turf on an athletic field can take without serious permanent damage. A dense, deeply rooted, springy turf actually reduces the number of accidental injuries to players and gives excellent footing. The person in charge of maintaining the field and the athletic director should agree on the following limitations for the use of the field:

1. The field must not be used when the upper soil layers have thawed and the lower layers are still frozen.
2. The turf must not be used in the spring until it has had time to recover from winter dormancy.
3. When the field is wet, it should be used as little as possible.
4. During practice, play areas should be rotated to allow recovery of those areas showing effects of wear.
5. Concentrated trampling, such as practicing band formations, should be avoided whenever possible.
6. Newly seeded areas should not be used until a mature turf has been established.

Fertility

Like home lawns, athletic fields require annual or semi-annual soil tests to determine fertility needs. Usually they need spring and fall applications of a complete fertilizer, but the appropriate analysis to be used may vary from one field to another. If the soil reaction is below pH 6.0, a mid-winter application of limestone is needed.

Football fields, especially football practice fields, are used heavily during late summer and early fall. Since most desirable turfgrasses are semi-dormant during late summer and early fall, it is usually necessary to supplement the rainfall with irrigation. With this irrigation, supplemental applications of slowly available forms of nitrogen are recommended.

Soccer fields are heavily used in spring and summer. Early spring applications of fertilizer are especially important to keep them in good condition.

Baseball fields are used spring, summer, and fall. Urea-formaldehyde nitrogen sources are especially useful in keeping a steady supply of nitrogen available to the grasses through this long period.

Figure 7. Athletic fields are subjected to heavy "traffic." Proper maintenance is essential.

Mowing

If the turf of athletic fields is not properly mowed, heavy use with spiked shoes will cause temporary and sometimes permanent damage. Proper mowing improves the wearing and increases the speed of recovery of turfgrasses. Mowing height and frequency are determined by the grass species and its growth rate. Grasses used in an athletic field are mowed somewhat higher than the same species used in the lawn. Kentucky bluegrass and red fescue should be mowed at 2 to 2 1/2 inches when possible. Tall fescue should be mowed at 2 1/2 to 3 inches. During spring and fall, when growth is rapid, mowing will be required every 3 to 4 days. During midsummer, the interval can be increased to every 5 to 7 days. When the grass has grown 1/2 inch above the mowing height, it should be mowed again.

Aeration

Aeration, as previously mentioned, is practiced on heavy soils to prevent or correct soil compaction problems. In addition to the spoon-type aerators for use on home lawns, hollow tubular-tine aerators may be used. This type of aerator should be closely observed while in operation. The plug-removers may become clogged with soil or small stones. Tractor-drawn aerators are normally used on athletic fields. Usually two to four passes from different directions are made over the same ground.

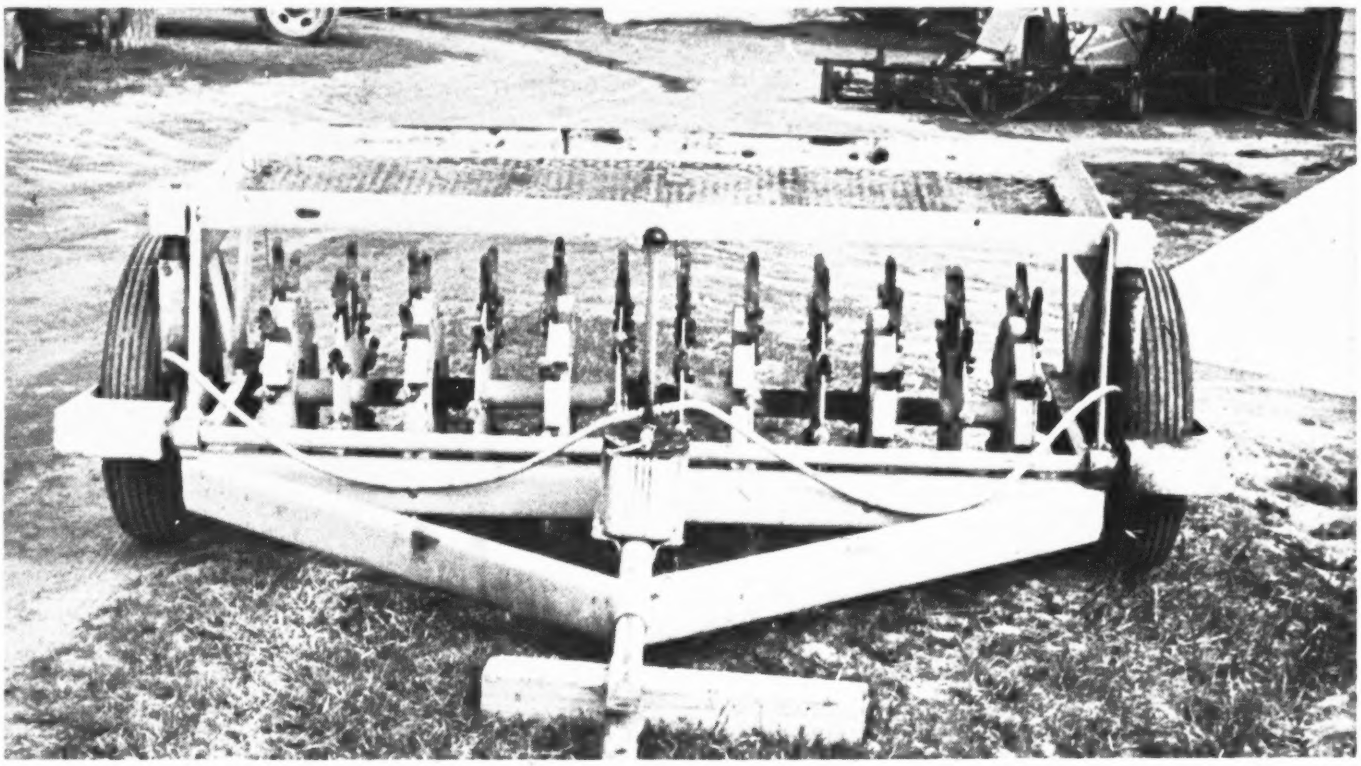


Figure 8. Tractor-drawn aerators are used to reduce soil compaction on athletic fields.

The best time to aerate is when the desirable grass species are actively growing, usually in the spring and early fall. Late fall aeration is sometimes done. Over-winter frost action, which further improves aeration, breaks up the walls of the holes made in late fall. The frequency of aeration varies according to the type of soil and the traffic to which the turf is exposed. Normally, aerations performed twice each year (spring and early fall) are sufficient. If compaction is a serious problem, once-a-month treatments may be necessary. In severe cases it may be necessary to modify the soil and establish a new turf. Applying fertilizers immediately after aeration, but before the plugs or cores are broken-up, is desirable. Peat or compost could be added at the same time. In hot dry windy weather, the turf should receive a thorough watering immediately after aerating. Turfs should not be aerated when soils are wet. If the aerators are used at this time, the walls of the holes where the plugs have been removed may glaze and crust or the plugs may not be pulled out of the ground. Glazing and crusting is especially likely to occur if a tubular-tine aerator is used.

Watering

Water applications should be made as they are on a home lawn. Water should be applied as infrequently as possible. However, each watering should be thorough enough to penetrate 6 to 8 inches into the soil. A medium-textured sandy loam soil should not be watered during the two-day period preceding a game. The two-day interval will allow the soil to dry out and help prevent compaction. For heavier soils with a large clay content, the period should be lengthened. For lighter soils with a large sand content, the period may be shortened.

Pest Control

Good management prevents weeds, insects, and diseases on athletic fields. If pests appear, the chemical controls mentioned in Problem Area 3 should be used. To avoid a possible health hazard to players, applications of these materials should not be made during the game season. For further information on pest control, see *Turf Management,* chapters 8-10, Reference No. 27.

Repair

Damaged turf may be repaired in two ways: by plugging and sodding, or by seeding.

Plugging and sodding are used for fields that have almost continuous use. Plugging is used for spots not over 6 inches in diameter, while sodding is used for larger areas. A hole cutter, such as the one used for setting cups in a golf course is used for cutting 3-inch-deep plugs from small damaged areas. A similar size sod plug is then placed in the hole.

In sodding, the first step is to remove the old turf from the area. Power sod cutters can be used for large areas. The soil is then prepared just as for a turf seedbed. The soil should be moistened before the sod is put into place. The sod is then lightly tamped in place and thoroughly watered.

The establishment of permanent grasses by seeding requires from 4 to 6 months. Since athletic fields are seldom idle for this length of time, other methods of repair are more frequently used. However, when an area is repaired by seeding, it is thoroughly aerated with 6 to 8 passes of the aerator and seeded with the appropriate seed mixture. Refer to the steps for seeding outlined later in this handbook.

If only 2 to 3 months are available for repair and if plugging or sodding are not possible, reseeding with common ryegrass (or perennial ryegrass) can be done as an emergency measure. The area should be aerated and prepared as outlined above for permanent grasses. Next, 6 to 8 pounds of common ryegrass are sown per 1,000 square feet. Over a period of a year or two, the permanent grasses bordering the area will invade and gradually replace the ryegrass.

All repaired areas must be watered daily until the seeds germinate or the sod develops roots in the lower soil. This repair requires about three weeks. Thorough watering will be needed weekly for the next 2 months.

Marking Playing Fields

Border, yardage, and end zone markings on playing fields are made with a special stripe painting machine. Water-based interior house paints, available in a wide range of colors, are often used for this purpose. These paints are not harmful to the turf. Once they have dried, they will not easily wash off. Accurate position and straight lines are essential in painting these markings. They are usually placed on the day before the game. For further information concerning the maintenance of athletic fields, see Athletic Fields, Reference No. 2.

Special Turfs

Special turfs include highway median strips, steep banks, slopes, dams, and dikes. The grasses most often used are a mixture of common ryegrass and tall fescue. However, crownvetch is often used on steep banks, because it requires no fertilizer applications, mowing or weeding.

Fertility Problems

Regular fertilizer applications are not usually made on special turf areas. Applying fertilizer to irregular slopes is both difficult and expensive. Usually fertilizer is applied only when the turf is established and again when the turf indicates a deficiency. Poor general appearance and thinning are the usual signs which indicate a need for fertilizer on these areas. Soil tests are used to determine the amount of fertilizer to be applied. Applications are made with large spreaders when the area is accessible.

Mowing

Mowing of special turf areas is usually infrequent. Some of these areas may be cut only 2 to 3 times per year. For some areas, such as median highway strips, the rate of grass growth may be controlled by the use of a chemical (such as maleic hydrazide). Maleic hydrazide inhibits plant growth and therefore reduces the number of mowings needed. Frequency of mowing is primarily governed by budget, equipment, and available help. Consequently, mowing height is not determined by the usual principle of not removing more than a third of the leaf surface. Mowing height is usually 2 1/2 to 3 inches. Large rotary mowers, gang reel-type mowers, flail mowers, or sickle bar mowers are used to mow special turf areas. For further information, see Turfgrass Guide For Lawns, Recreation Areas and Roadsides, Reference No. 25.

Herbicides

Weed killers are frequently used to control noxious weeds in special turf areas. The materials are the same as those used for residential lawns, but for economy reasons they are applied only in spray form. In order to avoid the hazard of "drift" damage to fruit and vegetable crops in the vicinity, mid-October application is recommended.

Test

1. How do the use requirements and maintenance practices for athletic fields and other special turf areas such as highways and playgrounds differ from those for lawn turfs?
2. What is the purpose of aeration?
3. When is the best time to fertilize irrigated athletic fields and playgrounds?
4. Describe the procedures for irrigating athletic fields.
5. What is the correct mowing height for athletic field grass mixtures?
6. How do athletic field grass mixtures differ from lawn grass mixtures?
7. How do athletic fields differ from lawns in terms of soil drainage?
8. How do athletic fields differ from lawns in terms of seeding rate?
9. What safety practices should be observed in the use of mowers and sprayers?

SUGGESTIONS AND REFERENCES FOR THE TEACHER

Athletic fields and other special turf areas such as highways and playgrounds have problems which are different from home lawns. The grass mixture is different because the use of the turf is different. Heavy traffic on these turf areas requires the use of different maintenance practices and special equipment.

Athletic fields are irrigated. Consequently, the fertility program is different from that of home lawns. Heavy traffic areas usually require aeration and a higher cutting height. Larger equipment is used to mow and spray the athletic field. It is very important to teach students to assess carefully the type of mixture grown, the soil conditions, and the uses of the turf before planning a maintenance program.

Learning Resources

References:

Athletic Fields. Reference No. 2.

The Aerator Manual. Reference No. 20.

The Verticut Manual. Reference No. 21.

Turf Management. Reference No. 27.

Turfgrass Guide for Lawns, Recreation Areas and Roadsides. Reference No. 25.

Visual Aids:

"Turf Care." Diamond Alkali Company, 4508 Granger Street, San Diego, California 92107.

Suggested Student Learning Activities

1. Take your students on a field trip to inspect carefully an athletic field where the proper grass species have been established, mowed to the correct height, and watered regularly to maintain the turf. Fall is a good time of the year to make the visit. Ask the superintendent to review maintenance procedures. Have each student complete a Turf Field Trip Observation Record Form. Take the time to make observations about each item on the form. Arrange the field trip so that the

operation of the equipment used to fertilize, mow, aerate, and irrigate athletic fields will be demonstrated.

2. Visit a highway maintenance department and discuss highway-maintenance problems with the maintenance supervisor. The teacher will need to make a planning visit before taking the class on the tour. Have each student complete a Turf Field Trip Observation Record form. Additional trips may be planned to the highway maintenance shop to discuss the use and operation of equipment. Discuss operational skills and job requirements with the supervisor. Some students may get occupational experience with the highway department.
3. If possible, have students, under proper supervision, repair the athletic fields of the school.
4. If possible, have students observe the application of herbicides and fertilizer to school athletic fields.
5. Demonstrate the effects of a growth retardant such as maleic hydrazide on special turf areas. A small test plot near the school can be useful for demonstration purposes. Ask students to record their observations of the growth of grasses in test plots.

Suggested Placement Experiences

1. For those students placed with athletic field supervisors, see that an opportunity is provided for students to mow, water, fertilize, and repair an athletic field.
2. For those students placed with highway maintenance supervisors, see that opportunities are provided for them to participate in the mowing, fertilization, and repair of highway rights-of-way and median strips.

PROBLEM AREA 5

MAINTAINING GOLF COURSES

Because of the increasing number of golf courses, the demand for skilled and semi-skilled golf course workers is growing. Employment opportunities are excellent for young men interested in this type of work. Some students will want to continue their high school and post-high school studies of golf course maintenance in colleges and universities. In the Northeast, The Pennsylvania State University has a program under which students receive class instruction during the winter months and are placed for occupational experience during spring and summer.

In the United States two billion dollars were spent on golf course turfs in 1965. Seventy million of this amount was spent on improvements, while the rest was spent on maintenance and construction of 8,000 new courses. This figure represents a 34 percent increase in the number of golf courses in one year.

Student Learning Objectives

1. To learn how to fertilize fairways, tees, and greens.
2. To learn how to irrigate, mow, and aerate fairways, tees, and greens.
3. To learn how to control pests on fairways, tees, and greens.
4. To learn how to accurately calibrate a fertilizer spreader.

Key Questions

1. What are the major parts of a golf course?
2. What are the major problems involved in maintaining golf courses? How do these problems differ from those of the home lawn? The athletic field?
3. What are the major activities involved in maintaining golf courses?

New Words

Cup - a hole or the metal container within it
Fairway - that part of a golf course between the tees and the putting greens
Green - the area of smooth, clipped grass surrounding the hole
Rough - any part of a golf course on which tall grass, bushes, etc., grow
Tee - an area in which the golf tee (small peg with concave top) is placed

Maintaining Golf Courses

Golf courses require more specialized maintenance than any other turf area. No other game is as greatly influenced by the condition of the turf. Greens, particularly, must be smooth, resiliant, and even-textured; if they are not, the golfer cannot accurately place a shot. The maintenance is further complicated by the fact that the areas of play are in almost continuous use during daylight hours from early spring to late fall. The names of the areas of a golf course "hole" are shown in Figure 9. After reading through this problem area, you may wish to study further in Turf Management, pp. 154-188, Reference No. 27, Guide for Preparation of Specifications for Golf Course Construction, Reference No. 11, and Fall Renovation of Greens and Fairways, Reference No. 9.

Fertility

Fairway

Golf course superintendents are confronted with various fertility problems in the maintenance of fairways, tees, greens, and practice fields. The fertility problems on bluegrass and fescue fairways are similar to those found in the home lawn. A fairway fertilization program should include an annual or semi-annual soil test and applications of fertilizer or lime as indicated.

Tees

The fertility problems associated with a tee are similar to both the fairway and the athletic field. The amount of traffic, wear, and compaction for a tee is similar to an athletic field. Bentgrass tees are, however, an exception. The fertility problems on a bentgrass tee are similar to those on golf course greens.

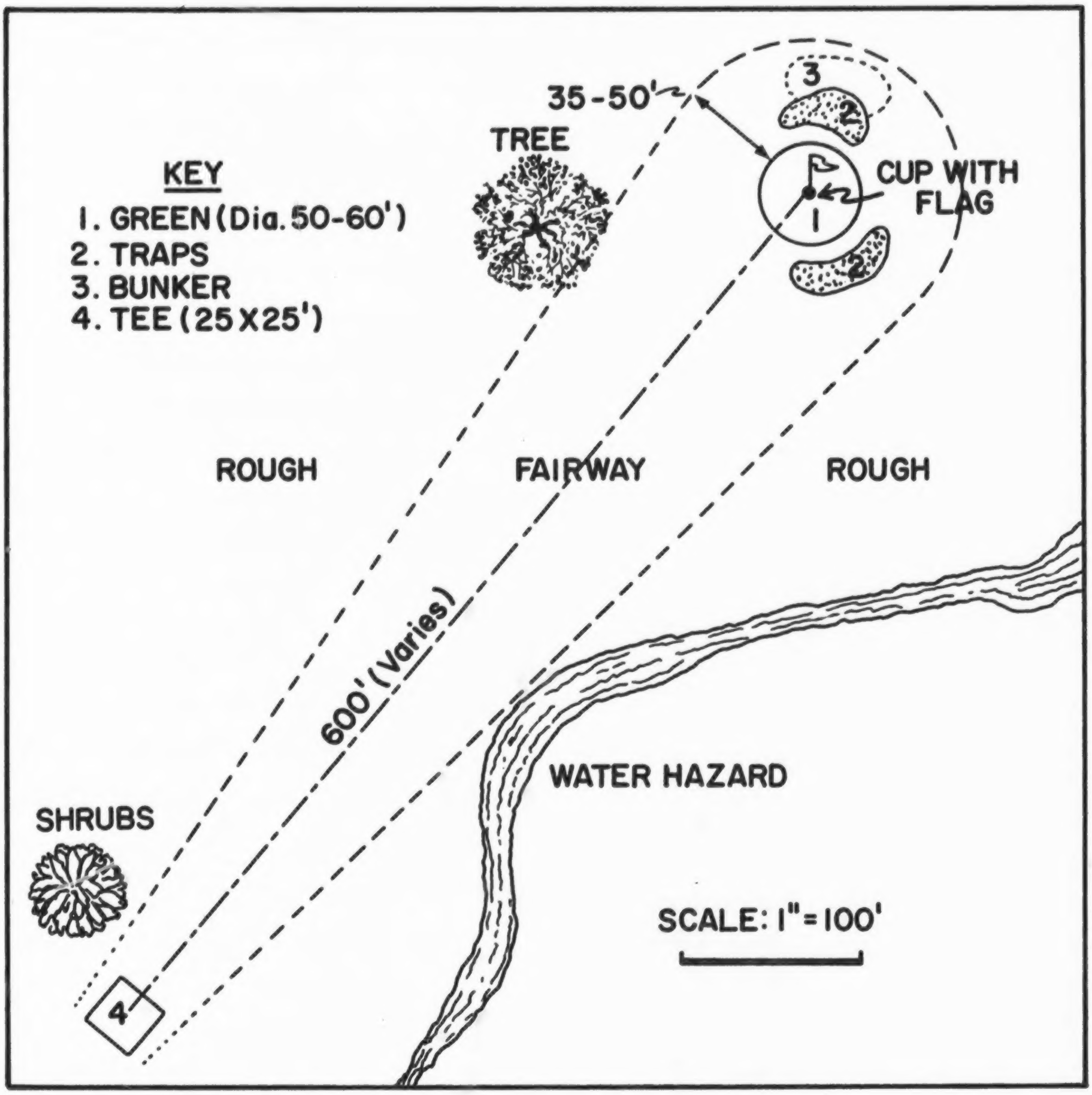

KEY
1. GREEN (Dia. 50-60')
2. TRAPS
3. BUNKER
4. TEE (25X25')
35-50'
TREE
CUP WITH FLAG
1
2
2
3
ROUGH
FAIRWAY
ROUGH
600' (Varies)
SHRUBS
4
WATER HAZARD
SCALE: 1"=100'

Figure 9. Areas of a golf course "hole."

Greens

Because of the growth habits of grasses grown on the greens (colonial and creeping bentgrasses), fertility problems of a green differ markedly from those of a lawn. The growth of grasses on the greens is very fast and low. As a result, they require frequent and close mowings. Also, these grasses on the greens need more fertilizer than those on the home lawn. They need more fertilizer, not only to keep growing and healthy, but also to retain a green color throughout the growing season.

Fertilizer programs on the greens are many and varied. The quantity of application, frequency, and grade of fertilizer depends on the soil test, the soil type, and the quantity and frequency of watering. Soil samples should be taken every spring. Many Pennsylvania golf courses have found that a 10-6-4 fertilizer (with a high percentage of urea formaldehyde as the nitrogen source) applied in late March, in July, and again in early September is satisfactory. Each application is made at the rate of 80 pounds of 10-6-4 per 1,000 square feet. Applications of ground limestone should be based on soil test results. Limestone may not be needed every year.

Mowing

Because of the demands of golf, the requirements for mowing golf courses are different from the requirements for lawns. The mowing height, frequency, and even the equipment used are determined by whether the area is a fairway, tee, green, or rough.

Roughs

On some golf courses the roughs are mowed only once in 2 or 3 weeks. On others they may be mowed as often as the fairways, but at a height of 2 1/2 to 3 inches.

Fairways

Fairways should be cut when needed -- not according to a schedule. Keep the grass low by mowing frequently. Do not remove more than 1/3 of the total leaf surface at any one time. Fairways usually contain bluegrasses, fescues and bentgrasses, separate or in various combinations.

The mowing height for each species should be the same as it would be if it were found in a home lawn. If mowing is not done correctly, Poa annua and other weeds are likely to invade.

Fairway mowing is usually done with tractor-drawn gang-reel-type mowers. They usually have tandom arrangements with five, seven, or nine units.

Tees

If tees are planted with bluegrasses and fescues, they should be mowed at the same height and frequency as fairways. If they are planted with bentgrasses, they should be cut about 1/4 to 1/2 inch high and at the same frequency as a green.

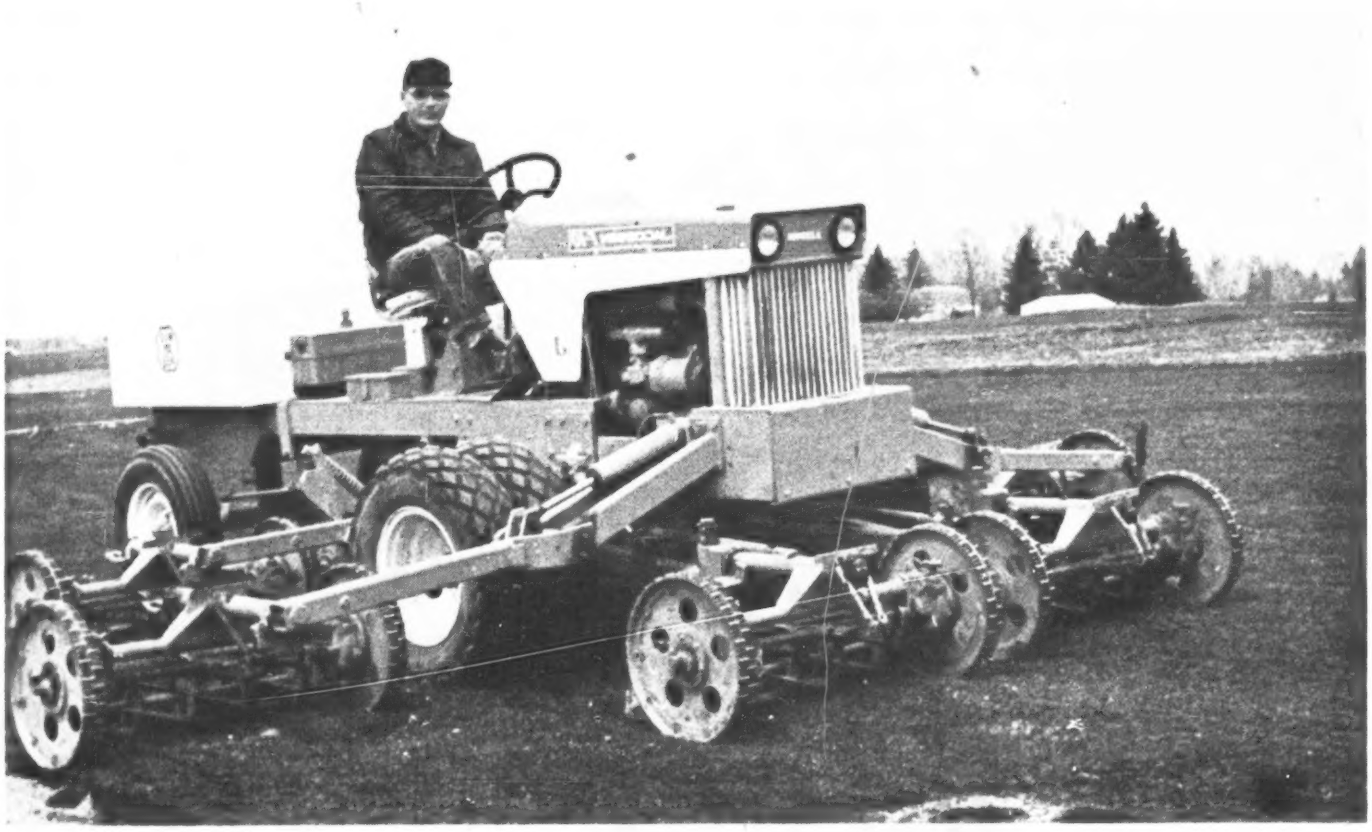


Figure 10. Large, tractor-drawn, gang-reel mowers are used to mow golf fairways.

Greens

Greens are nearly always planted with one of the bentgrasses. Bentgrasses grow very fast. Generally, the bentgrasses on a green are mowed to heights of 3/16 to 3/8 of an inch. Collars are strips of grass, approximately 2 feet wide, surrounding the greens. They are mowed to a height of 1/2 inch. Greens look better and retain a better playing surface if mowed daily.

Aprons are strips of grass, approximately 4 feet wide, which surround the collars. They should be mowed to a height of 1 inch. Special 7-blade reel-type mowers are used on greens. These mowers are more expensive and require more care than the regular reel mowers used on home lawns. They are adapted for close cutting on smooth surfaces.

The greens should be mowed in straight parallel lines. Each time the green is mowed, it should be mowed in a different direction. This practice helps prevent "grain" from developing.

Dew often accumulates on golf greens overnight. To improve mowing conditions, the dew should be removed by "whipping." "Whipping" (brushing) is done by making circular brushing strokes with a reed pole held horizontally at the grass surface. Wet grass clippings cling to the mower and form clumps; when mowing is completed, the clumps must be cleaned from the mower.

Clippings

Clippings are not normally removed from the fairways. However, some golf courses remove the clippings to prevent thatch build-up. Clippings should be removed from the tees if they are long enough to interfere with play. Clippings should be removed from the greens. However, there is an exception: during the first 3 days after an application of granular fertilizer materials, clippings should not be removed.

Aeration

Soil compaction is likely to occur in areas of heavy traffic, such as the approaches to tees and greens. Traffic is especially a problem on heavy soils. Compaction compresses the soil, reduces the size of the air spaces, and causes poor root growth. A poorly functioning root system causes poor top growth, and the health of the turf declines.

When soil compaction is a problem, special machines are used for improving soil aeration. These machines remove plugs of soil about 1/4 inch in diameter and about 2 inches in depth. Usually three to four passes from different directions are made over the same area.

If there are heavy soils, many golf courses need to be aerated on a scheduled basis. Fairways are aerated once a year, in spring or fall. Tees and greens may be aerated twice a year, in spring and fall. If compaction is a severe problem, aerifying might be done as often as three or four times a year.

When greens have been aerated, the plugs are usually removed from the surface. A mowing removes any tufts that stick up. The entire green is then given a light top-dressing of compost or peat. Finally, the top dressing is swept into the holes made by the aerating equipment.

After tees and fairways have been aerated, the plugs are usually broken up and scattered over the turf by dragging a metal mat over the surface.

Spiking, which also improves aeration, is done with a machine that punches holes in the soil, rather than removing soil plugs. Spiking is useful only if done in the very late fall. The alternate freezing and thawing during the winter breaks up the compressed walls of the holes made by spiking.

Thatch

Thatch is the build-up of undecayed dead leaves and roots at the soil surface in a turf. If this accumulation becomes heavy enough to interfere with water and air penetration, the turf may die. Examination of a turf plug will reveal whether thatch has accumulated in excessive amounts.

Heavy thatch may be caused by two things. One is infrequent mowing without removing clippings. The other is the failure of soil microorganisms to break down the accumulated material because conditions are unfavorable for their activity. A soil pH below 6.0 and lack of air and moisture are conditions that adversely effect the activity of these soil microorganisms. Using proper mowing practices will remedy thatch accumulation caused by infrequent mowings.

However, if soil conditions are adverse to microorganisms, the turf should be thoroughly aerated, (follow the treatment earlier described for compacted soil). It is then vertically mowed. The machine should be adjusted so the blades cut into the thatch, but not into the roots of the turf grasses. The exact cutting depth will be determined by the depth of the thatch and by the kind of turf. When this treatment is used on a putting green, special care must be taken to have exactly the right depth of blade, or severe damage to the turf may result. After only one pass with the aerator is made over the area, the thatch lifted to the surface should be removed with lawn rakes or lawn sweepers. The treatment area is then fertilized with ground limestone and top-dressed with a mixture of 85 percent sand and 15 percent peat at the rate of 1/4 to 1/2 cubic yard per 1,000 square feet. Finally a steel mat is dragged over the area to work the top dressing into the turf.

Renovation for thatch control is best done in the spring or fall. Light applications of ground limestone once a year help maintain a pH range of 6.0 to 7.0. This pH range is favorable for microbial activity and helps prevent thatch problems.

Watering

Fairways

The rules applying to lawn watering also apply to fairway watering.

Tees

Like fairways, tees should be watered according to the same rules for home lawns, unless they are planted with bentgrasses. If they contain bentgrasses, they should be watered according to the principles for watering greens.

Greens

Greens should be watered enough to prevent shallow root growth. Water applications have to be made more frequently than on a home lawn, because bentgrasses grow quickly. The watering frequency also depends on such factors as soil type, temperature, and wind. Conventional water sprinklers connected to an underground irrigation system are normally used to water greens. Localized dry spots should be watered by hand.

During periods of high temperatures and especially during periods of high winds, wilting often occurs. Wilting occurs because the grass leaves lose water faster than the roots take it up. Wilting can take place even when the soil is thoroughly wet. This condition is corrected by syringing. Syringing is done by lightly sprinkling the green several times during the hottest part of the day. Syringe at noon and again in mid-afternoon. Syringing is usually done by hand watering.

Pest Control

There are many pest control programs for a golf course. Programs vary from weekly preventative spraying to control measures applied only when pests become a serious problem. Chemical controls for insects and diseases should follow those recommendations listed in the section on lawns. Unless it is a bentgrass fairway, weeds on the fairways should be controlled by following the recommendations for weeds on home lawns. Many herbicides which are safe to use on other grasses may be injurious to bentgrasses. On tees and greens, weed problems are minimum because the grass is cut so short. Weed removal on greens is sometimes best accomplished by hand. For further information on pest control, see Turfgrass Management, chapters 8-10, Reference No. 27. Also refer to Problem Area 3 of this handbook.

Wear Distribution

Two small turf areas on a golf "hole" are subject to very heavy wear -- the tee, and the edge of the cup on the green. Special steps should be taken to overcome this traffic.

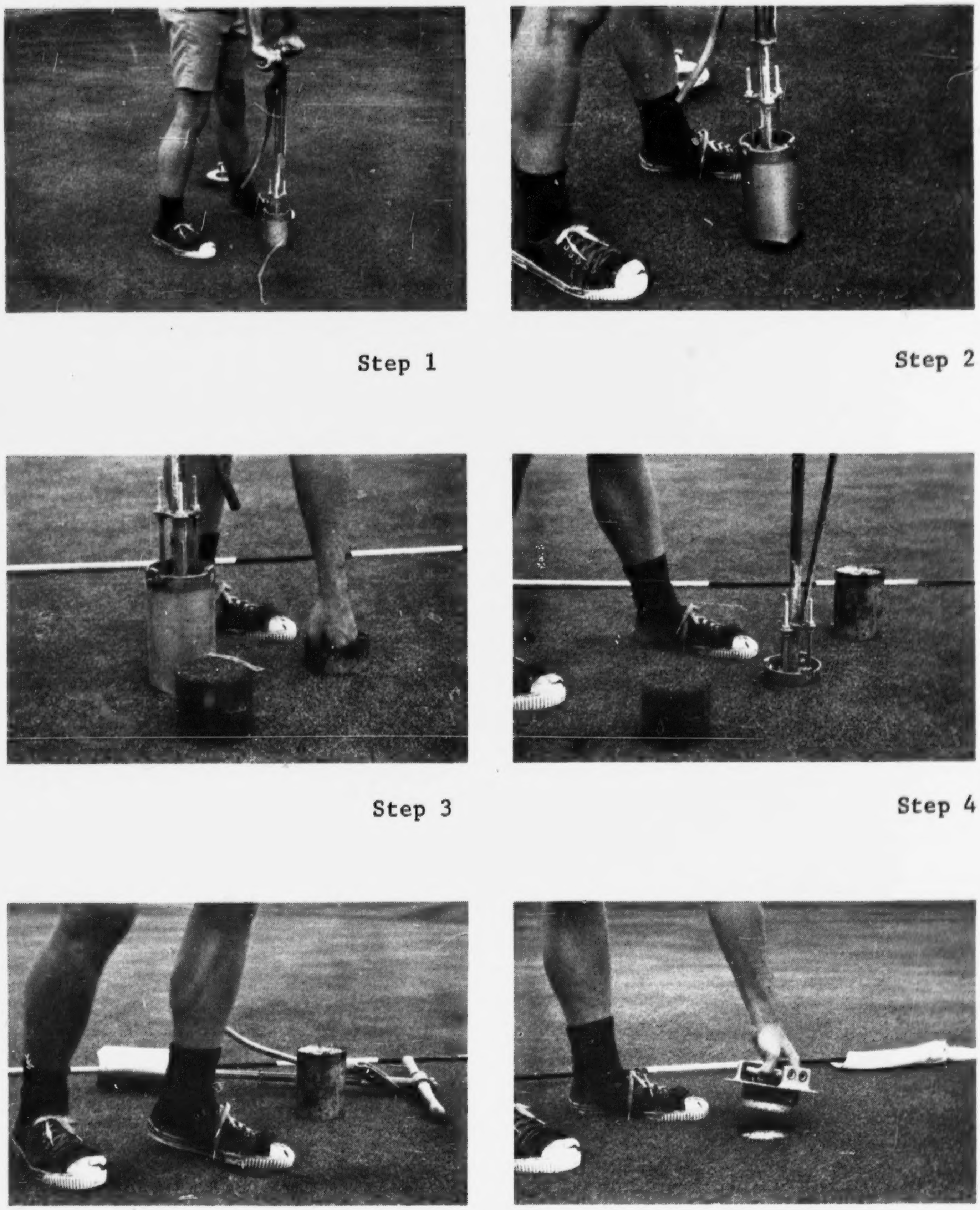
In "teeing off", players may accidentally aim too low in striking the ball. A small piece of sod called a "divot" is thus lifted out. Considerate golfers replace divots and then step on them to firm them in place. "Please replace divots" is a sign often seen at the first tee.

Divots require a week or two to become firmly rooted into the soil. To allow time for "healing" to take place, only 1/3 to 1/4 of the tee area is actually used at any one time. The area available for use is usually marked with four white balls on spikes. These markers are moved to another part of the tee every 4 to 5 days. The tee-off areas are thus rotated so each is only in use for 4 to 5 days and then "rested" for about 2 weeks.

On a green, the turf at the edge of the cup becomes frayed and uneven in only one day of heavy use. Frayed turf seriously affects the speed and direction of a slowly-moving putted ball. Therefore, the cup position is usually changed each day. A new hole is cut into the sod with a special tool. The plug removed to make the new hole is simply inserted into the old one and firmed in place with the foot. The cup position is usually kept somewhere within 10 feet of the center of the green. See Figure 11.

"Repair ball marks" -- this sign refers to ball marks in the turf of a green. A golf ball that has been hit high and a long distance, hits the green with enough force to cause a dent in the turf. This dent can interfere with the rolling of a putted ball. They are repaired by gently lifting up the grass blades with the end of a golf tee, or a special tool that golfers often carry for this purpose.

"Rake traps" -- this sign is frequently present at sand traps. A ball that lands in a sand trap has to be played out of it. Usually this process roughs up the area. Players are expected to rake the area smooth afterward. A rake is kept at each trap for this purpose.



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Figure 11. Changing the cup. Steps: (1) cutting new hole, (2) lifting plug, (3) lifting metal liner from old hole, (4) putting bottom half of plug in old hole, (5) firming top half of plug in old hole, and (6) checking 1" depth of rim of metal liner in new hole.

Test

1. Define: (1) fairway, (2) green, (3) tee.
2. What type of turfgrasses are best adapted for use on fairways? Greens? Tees?
3. How do fairways, tees, and greens differ in their requirements for the following items:
    a. fertilizer and lime?
    b. mowing and aerating?
    c. watering?
    d. pest control measures?
4. Describe the maintenance practices used on golf fairways, greens, and tees.
5. Which parts of the golf course are subjected to the greatest wear?
6. If root development of a turfgrass area is very shallow, what recommendations would you make about watering this area?
7. When should clippings be removed from the golf course? When should they be left on the grass?
8. What two things cause thatch accumulations? How can turfgrass areas suffering from excessive thatch accumulations be helped?
9. What are some causes of poor soil aeration? How can this condition be corrected?
10. What are golf course roughs? How often are they mowed?

SUGGESTIONS AND REFERENCES FOR THE TEACHER

The maintenance of golf courses requires a thorough knowledge of turfgrass management principles and practices. Golf courses require meticulous care. Valuable golf courses have been seriously damaged by inexperienced workers. Employers of persons working in turf occupation have had to depend upon on-the-job training programs to obtain qualified employees. Student study, work experience, and other forms of involvement in the maintenance of golf courses should be very helpful to those who seek careers in these occupations.

Learning Resources

References:

Guide for Preparation of Specifications for Golf Course Construction. Reference No. 11

Fall Renovation of Greens and Fairways. Reference No. 9

Supplies:

1. Fertilizer
2. Grass seed
3. Spray chemicals
4. Sand
5. Peat
6. Soil
7. Screen
8. Soil mixer
9. Shovels, rakes, etc.

Suggested Student Learning Activities

1. Take a field trip to several golf courses to discuss maintenance practices with the superintendents. Each student in the class should complete a Turf Field Trip Observation Record form for a fairway, a tee, and a green. Note maintenance practices used on each.

2. Demonstrate and provide students with opportunities to practice the operations used by a golf course worker. These operations include the following: (1) taking a soil test on a tee, green, and fairway; (2) calibrating and applying fertilizer on a tee and a green; (3) using mowing equipment; (4) aerating soils; (5) vertical mowing; (6) applying top-dressing materials to golf greens; (7) irrigating golf courses, including automatic, semi-automatic, and hand-watering methods, and (8) controlling special pest problems on golf courses.

Suggest Placement Experiences

1. Students should fertilize, water, and mow fairways, tees, and greens.
2. Students should make turfgrass repairs on fairways, tees, and greens.
3. Students should diagram the layout of the entire golf course where employed and label each area with the type of turfgrass.
4. Students should observe chemical pest-control activities.
5. Students should operate, for a short period of time, each piece of equipment.
6. Students should prepare a calendar of the major maintenance activities taking place on the course during each month of the year.

PROBLEM AREA 6

PLANNING AND ESTABLISHING NEW TURFGRASS AREAS

Student Learning Objectives

1. To learn how to grade, prepare a site, and prepare the seedbed for establishing new turf areas.
2. To learn how to determine rates of fertilizer and lime to apply to new turf areas.
3. To learn how to select quality seed and adapted seed mixtures.
4. To learn appropriate seeding times for establishing new turf areas.
5. To learn how to care for young grass.
6. To learn when and how to renovate old turf areas.

New Words

Agricultural tile - porous tile made of fired clay

Calibrate - to adjust the rate of distribution

Contour - shaped to fit the outline or shape of something

Emulsion - a liquid mixture in which a fatty or resinous substance is suspended in small globules

Grade - to change existing contours

Pesticide - a chemical used to control plant, animal, pests or disease

Renovate - to repair, renew

Sprigging - establishing a turfgrass area by using sprigs of grass

Swale - a shallow ditch in the landscape

Top Soil - dark soil layer extending from the surface to a 6-8 inch depth

Key Questions

1. What procedures should be used when grading a construction site?
2. Why is good soil drainage necessary for turfgrasses?
3. Why is lime usually needed in establishing a new lawn?
4. How are fertilizer spreaders calibrated?
5. Why is it important to test soil (pH and fertility) before establishing a new turf area?
6. What materials may be added to the topsoil to improve conditions for plant growth?
7. Why do costs of seed mixtures vary?
8. What time of year is best for seeding a new turf area?
9. Why is it important to mulch a newly seeded area?
10. What materials may be used for mulching?
11. What determines when new grass should be mowed the first time?
12. How does one renovate an old turf area?

Planning New Turfgrass Areas

The problems of maintaining a lawn are reduced if care is used in establishing it. You should carefully plan a new turf area before starting construction. The site should be examined to determine the grading requirements, drainage and irrigation needs, and fertility needs. Materials to be added to improve the soil condition must be considered. The kind, quality, rate, and time of seeding must be determined. The mechanics of seedbed preparation and the methods of seeding should be decided. The need for mulch and the types of mulches to be used must be determined. The care to be given new seedlings should not be overlooked. When all these needs for a new turf area have been determined, you can make a plan for meeting such needs.

Planning the Grade, Drainage and Irrigation

Grading

The existing contours of the area may have to be changed to eliminate pockets in which water collects. The soil level must slope away from all buildings at a minimum of 1/4 inch per foot. Turfgrass areas should have gentle, even slopes to carry away surface water. Uneven or bumpy surfaces must be made smooth for ease of maintenance and for a pleasing appearance.

First, all topsoil (the darker soil near the surface, usually about 6 inches deep) is removed from the construction area of a building and from areas where grade changes are to be made. The topsoil is then stockpiled in an unused area until the building is constructed; contour changes are made; and irrigation lines, drainage lines, and utility lines are installed. This topsoil is essential for a new lawn and must never be discarded or sold. If there is excess soil, only subsoil should be discarded.

Trash left from construction--such as pieces of lumber, shingles, paint cans, and building plaster-- should never be used as fill. Trees, shrubs, or bushes removed during grading should not be buried. Future drainage and settling problems will be created by burying these items. Dry areas may result from limited soil depth over buried trash.

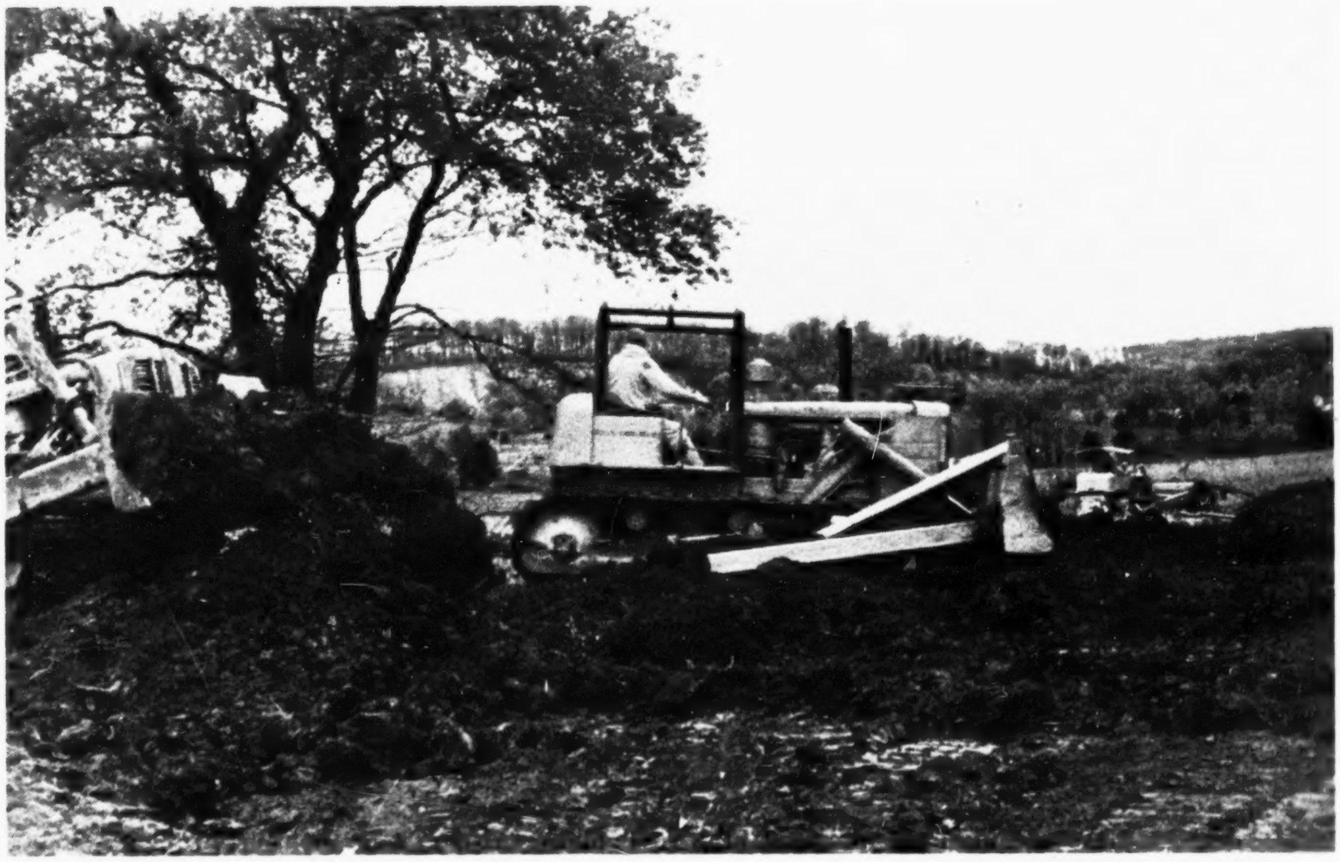


Figure 12. After establishing the desired contour, the topsoil is returned to form the final grade.

After construction is finished, "rough grading" of the subsoil is done. Grading large areas should follow a planned contour drawing prepared by an architect. To achieve the desired contour, stakes are set at appropriate intervals and marked to indicate the amount of subsoil to be removed or added. It is important to have the grade of the subsoil conform to the contours shown on the architect's plans. He usually calculates the amount of soil needed for cuts and fills so that it is equal. No soil then needs to be trucked to or away from the site.

"Final grading" is done by putting the topsoil in place on top of the subsoil. It should be at a uniform depth over the entire area -- preferably not less than 6 inches.

Drainage

Deep root systems result in healthy, strong, drought-resistant grass. Good drainage is necessary for deep root systems. The ideal soil for root development has 50 percent solid matter and 50 percent pore space. In this soil, one-half of the pore space is filled with water; the other half by air. Roots need oxygen to absorb water and nutrients. Absorption of oxygen and nutrients is restricted when soil is compacted or pore space is filled with water.

There is good drainage when water moves rapidly into the soil. When the soil is wet and soggy and when water stands in depressions for more than 30 minutes after a moderately heavy rain, the drainage is poor. Soggy soils may be caused by a layer of material below the soil surface that does not permit water to drain through. Seepage of water from other areas may also be the cause of wet soils. A tile drainage system may be necessary to correct these conditions.

Drainage systems are installed before final grading and seedbed preparation begin. Usually 3- to 4-inch agricultural tile, made of clay, is used in the system. Normally, tile is placed in a trench 18 to 30 inches deep. Some soil conditions will require deeper tile placement. A drop of 3 to 6 inches per 100 feet of tile line will prevent water from standing in the tile. The tile is fitted as tightly together as possible. Covering the tile joints with fiberglass strips or asphalt paper prevents soil from entering the line. Three to four inches of small stones should be put into the trench before it is refilled with soil. The coarse material permits water to move freely into the tile.

Outlets of tile systems may be connected to storm sewers. They also may be emptied into a stream, pond, or open drainage ditch. Screens are placed over outlets to keep out destructive animals such as muskrats. Before a tile drainage system is installed, it is wise to consult with persons who have had experience in installing field tile.

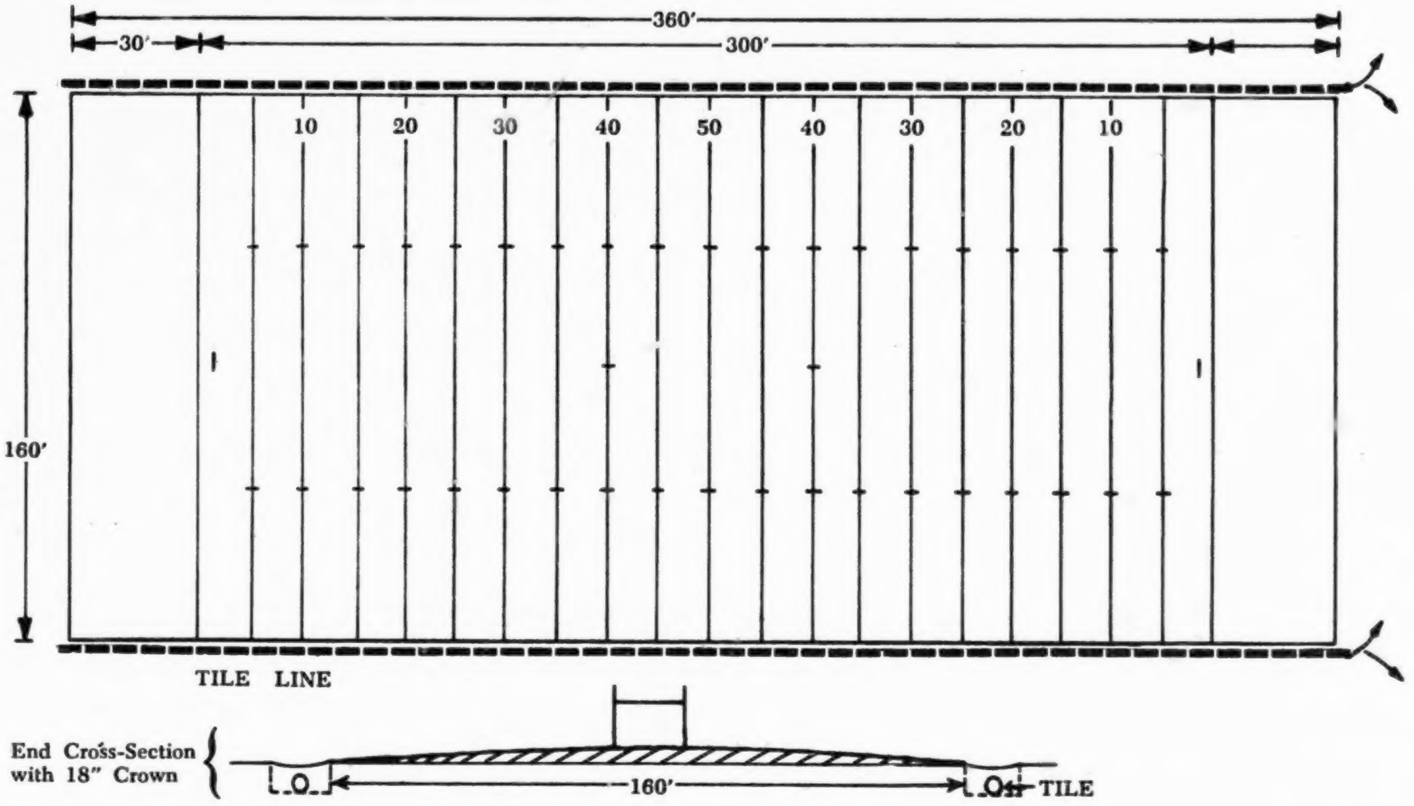
Grading and Drainage of Athletic Fields

Grading for surface drainage is particularly important on athletic fields. Crowning (that is, forming a turtle-backed slope from the center to the sidelines as shown in Figure 13) of the fields is necessary for proper surface water drainage. A system of tile and catch basins along the sidelines is used to remove the excess surface water.

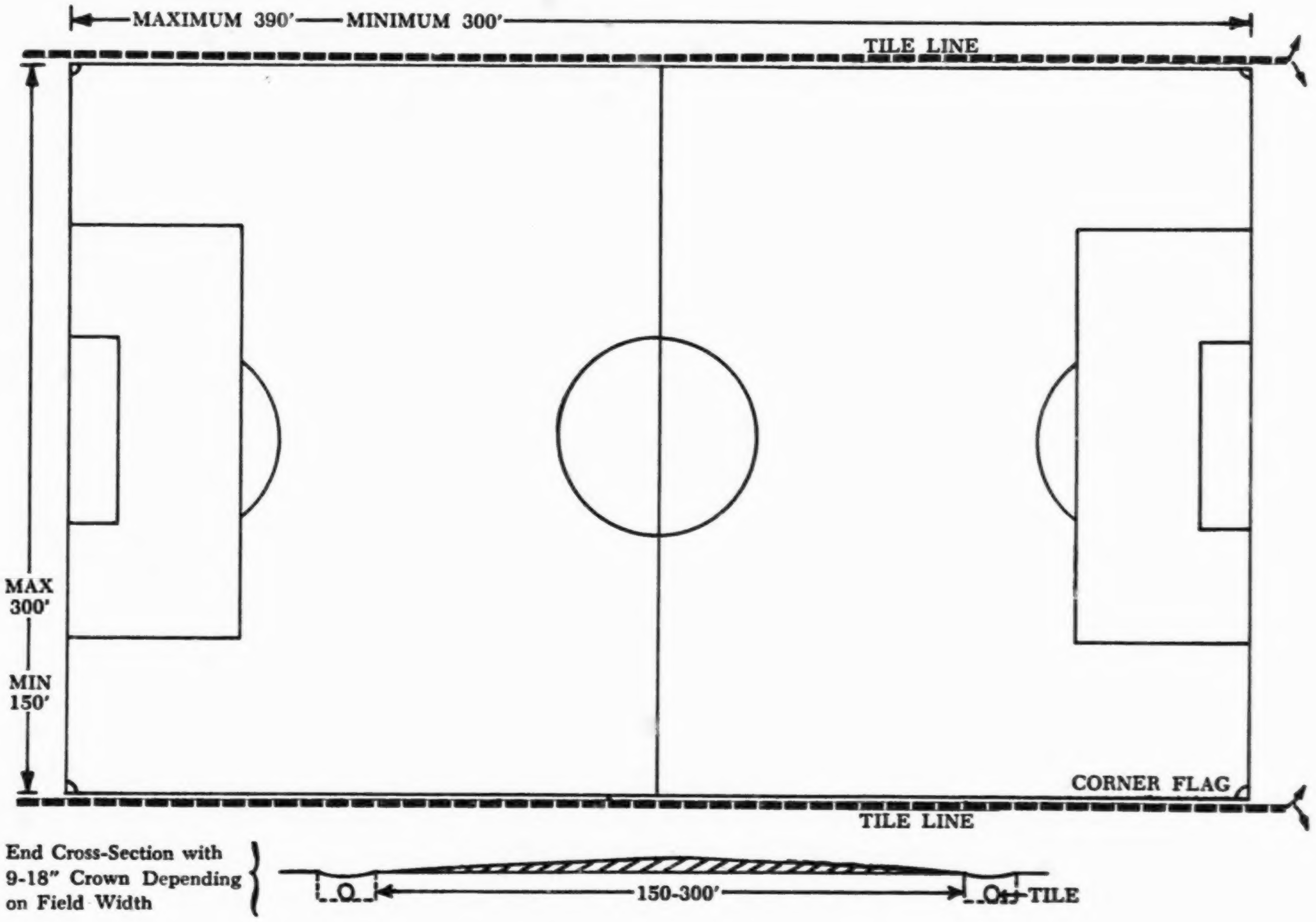
A football gridiron should have an 18-inch crown. Soccer fields should be designed with a drop of not more than 1 percent from the center of the field. A drop of more than 1 percent makes side shots in soccer very difficult. The parallel sidelines of football gridirons and soccer fields should be level. Tile lines with catch basins placed along the sidelines will remove water that cannot be absorbed through the soil.

The pitcher's mound of a baseball diamond is elevated above home plate and the baselines. The slope of the mound should be turtle-backed and blend smoothly into the infield area at the edge of the mound. The infield is graded with a slope of not more than one percent (1 foot per 100 feet) from the edge of the mound to the baselines. Tile lines are placed under the outer edge of the skinned area (infield) to remove excess surface water. These lines may be drained away from the play area in any manner which meets the local conditions. The outfield is graded (in all directions) to not more than 1 percent slope from the center. If necessary, the water is carried off at the edges of the outfield by a catch-basin tile system. (See Figures 14 and 15).

Figure 13.


360'
30'
300'
10
20
30
40
50
40
30
20
10
160'
TILE LINE
End Cross-Section with 18" Crown
160'
TILE

Field plan of football gridiron showing end section and tile lines.


MAXIMUM 390'—MINIMUM 300'
TILE LINE
MAX 300'
MIN 150'
CORNER FLAG
TILE LINE
End Cross-Section with 9-18" Crown Depending on Field Width
150-300'
TILE

Plan of soccer field showing end section and tile lines.

Field Plans provided through the courtesy of the Pennsylvania Agricultural Extension Service.

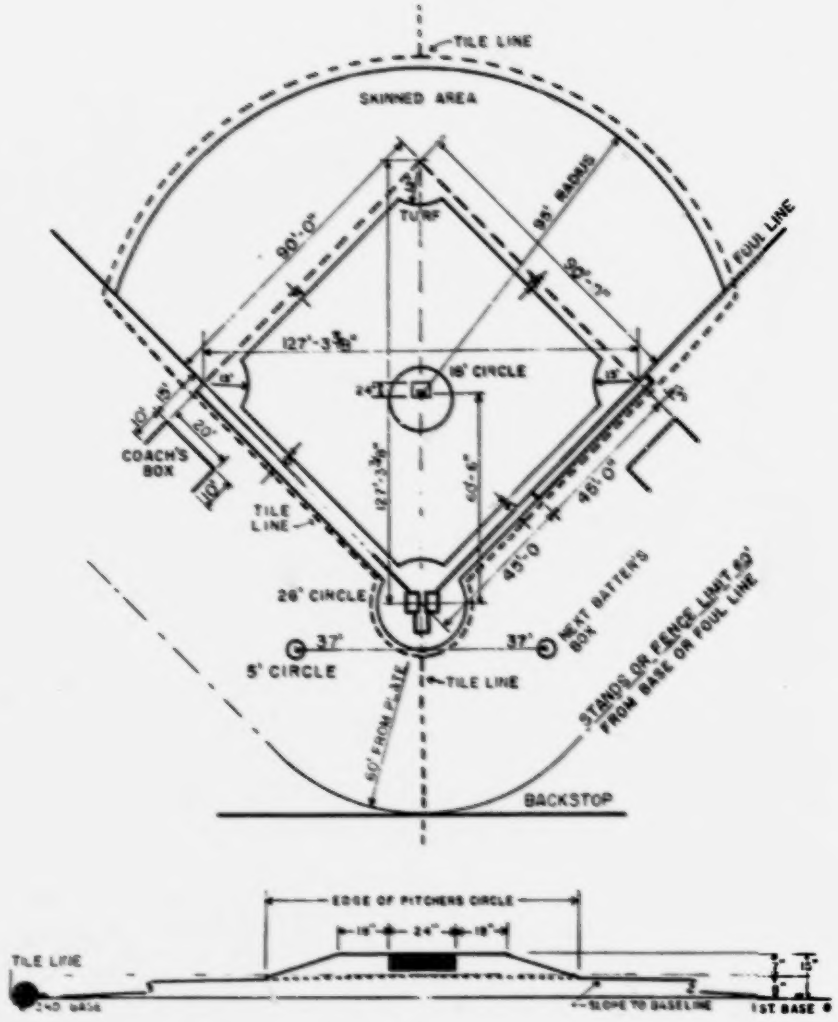

TILE LINE
SKINNED AREA
TURF
90'-0"
95' RADIUS
90'-7"
FOUL LINE
127'-3⅜"
18' CIRCLE
COACH'S BOX
TILE LINE
60'-6"
45'-0"
46'-0"
26' CIRCLE
37'
5' CIRCLE
NEXT BATTER'S BOX
STANDS OR FENCE LIMIT 60' FROM BASE OR FOUL LINE
60' FROM PLATE
BACKSTOP
EDGE OF PITCHERS CIRCLE
18"
24"
18"
15"
SLOPE TO BASELINE
1ST BASE
3RD BASE

Figure 14. Field Plan of Regulation Baseball Diamond Showing Design of Tile System.

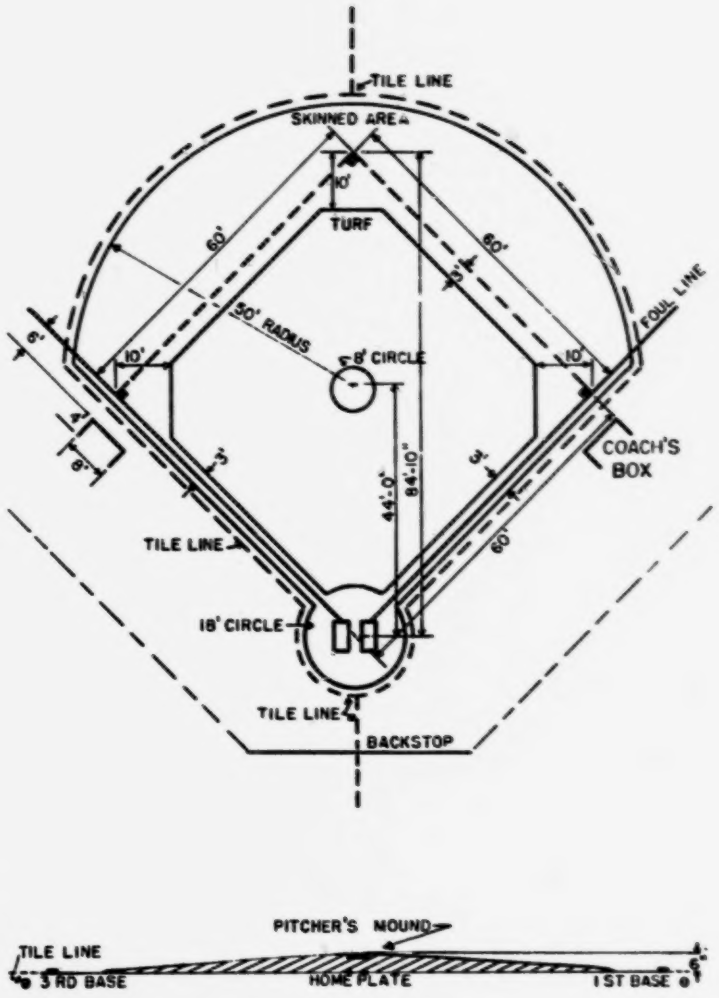

TILE LINE
SKINNED AREA
10'
TURF
60'
50' RADIUS
8' CIRCLE
FOUL LINE
6'
4'
8'
3'
COACH'S BOX
44'-0"
84'-10"
TILE LINE
18' CIRCLE
BACKSTOP
PITCHER'S MOUND
3 RD BASE
HOME PLATE
1ST BASE
6"

Figure 15. Field Plan of Little League Baseball Field Showing Design of Tile System.

Field plans provided through the courtesy of the Pennsylvania Agricultural Extension Service.

Drainage of Golf Tees and Greens

Adequate subsurface drainage for golf greens and tees is essential. The drainage system is installed during construction. Tile drains are used except where the subsoil allows water to pass through rapidly.

The contour of the green is graded 22 to 24 inches below the final elevation. The subsoil is graded in swales 10 to 20 feet apart as shown in Figure 15. Clay tile is laid in the swales (see Figure 15) and fitted as tightly together as possible. A straight tile line with a fall of 0.5 percent to 3 percent will prevent water from accumulating. The tile should be covered with tar paper or fiberglass and then with crushed stone. The entire subgrade is finally covered with 6 to 8 inches of 2B or 1B limestone. A base of this type provides for adequate drainage if the soil mixture allows water to enter the tile.

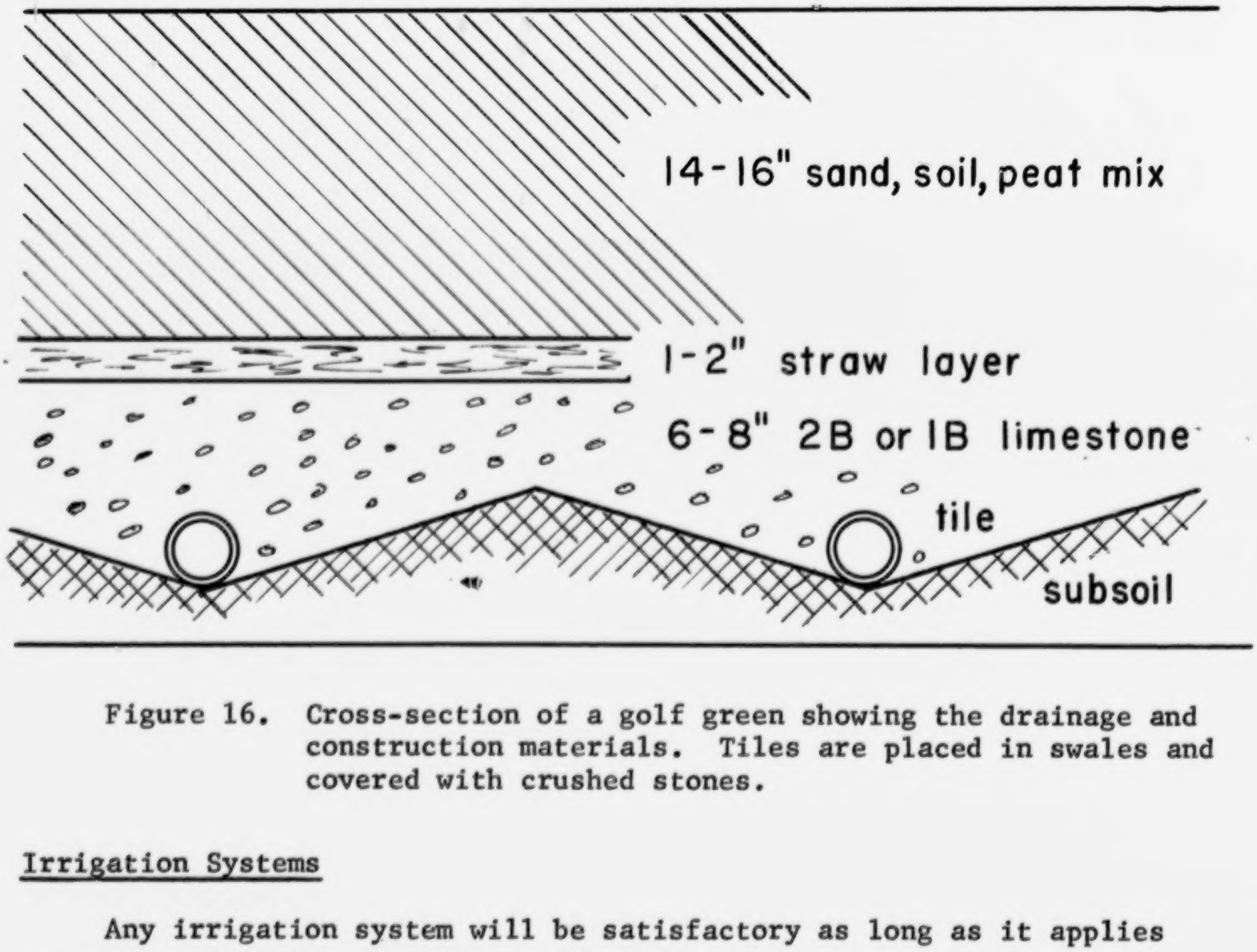


Figure 16. Cross-section of a golf green showing the drainage and construction materials. Tiles are placed in swales and covered with crushed stones.

Irrigation Systems

Any irrigation system will be satisfactory as long as it applies water to the grass at a uniform rate. The water should be absorbed by the soil without run-off. The type of sprinkler system chosen will depend on considerations of convenience and expense. Underground systems using permanent heads or snap valves are more convenient, but more expensive.

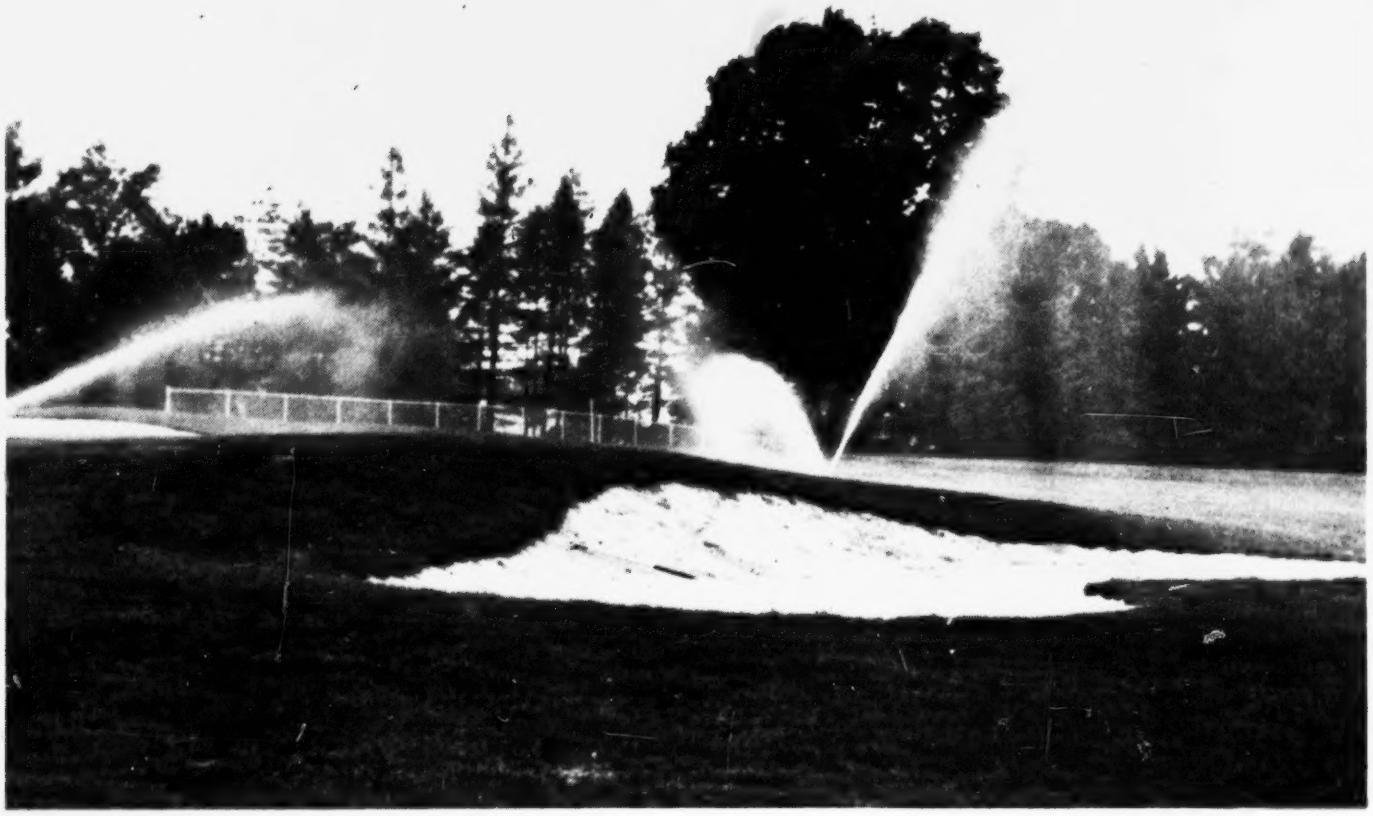


Figure 17. A permanently installed irrigation system is often used for irrigation of golf courses.

The simplest kind of sprinkler system is a small portable sprinkler attached to a garden hose. Examples are perforated hoses, rotary sprinklers, oscillating (back and forth) sprinklers, and traveling rotary sprinklers.

There are several types of stationary underground sprinkler systems which use different types of sprinkler heads. For small turfgrass areas, the underground system may have small heads set flush with the soil surface. The heads are spaced on the pipeline to give uniform coverage. Pop-up heads, which automatically rise about 2 inches above the surface when the control valve is opened, are also available.

Rotating sprinklers are used to irrigate large turfgrass areas. These may be connected directly to permanent quick coupling valves installed at suitable intervals in the pipeline. If the location of the sprinkler needs to be changed, a hose may be used to connect the head to the valve.

Underground watering systems for average-size residential properties should be arranged in four equal areas and valved so that only one area is watered at a time. The water mains to residential properties have a limited capacity, and the water pressure will drop severely if an attempt is made to water too large an area at one time.

Many factors must be considered when designing and installing an irrigation system: source of water; water pressure; pipe and hose lengths and diameters; friction losses in pipes, valves, and fittings; spacing of outlets and stationary sprinkler heads; the prevailing wind pattern; and semi-automatic or automatic controls. A competent irrigation engineer should be employed to design and direct the installation of irrigation systems for extensive turf areas.

Selecting and Applying Fertilizers

Fertilizer Materials

A wide variety of commercial materials for fertilizing lawns are available. Lawn fertilizers are more expensive than fertilizers for farm crops, because they are more concentrated, contain specially manufactured slowly available nutrients, and may be combined with weed killers or materials for controlling insects and diseases.

The numbers 10-6-4 or 10-5-5 on a bag of fertilizer indicate the "grade." According to law, the grade must be given on the container. Grade represents the minimum guaranteed percentage of nitrogen (N), available phosphate (P_2O_5), and water soluble potash (K_2O) in the fertilizer. The nutrients are listed in the following order -- N, P_2O_5, K_2O. The percentage sign is omitted by custom. An 80-pound bag of 10-5-5 fertilizer contains 8 pounds of nitrogen (N) (10% of 80 lb.), 4 pounds of available phosphate (P_2O_5) (5% of 80 lb.), and 4 pounds of water soluble potash (K_2O) (5% of 80 lb.). Thus an 80-pound bag of 10-5-5 fertilizer contains 16 pounds of nutrients available to plants. The remaining 64 pounds is composed of carrier material and filler. These materials increase the bulk so that the fertilizer is easier to spread.

A fertilizer ratio is the relationship existing between the percentages of nitrogen, available phosphates, and water soluble potash in a fertilizer. A 12-6-6 grade fertilizer has a ratio of 2-1-1. A 10-5-5 grade fertilizer also has a 2-1-1 ratio. A fertilizer ratio is calculated by dividing the smallest number in the grade into each of the three numbers. Usual fertilizer recommendations for lawns are for fertilizers having 2-1-1 ratios. Different ratios are recommended for other plants. For example, a 1-1-1 ratio is often recommended for vegetables.

A fertilizer material is a substance that contains at least one plant food element. A mixed fertilizer is a combination of materials that will supply more than one plant food element. A fertilizer which contains the three primary food elements, nitrogen (N), phosphorus (P), and potassium (K) is called a complete fertilizer.

Most mixed or complete fertilizers have either superphosphate, double or triple superphosphate, or ammoniated phosphates as a source of available phosphate (P_2O_5). The source of potash in most mixed or complete fertilizers is muriate of potash (also called potassium chloride).

Nitrogen-carrying materials may be either quickly available or slowly available. Quickly available nitrogen fertilizers include such materials as ammonium sulfate, ammonium nitrate, sodium nitrate, or urea (a synthetic material). The nitrogen in these fertilizers is water soluble and this becomes quickly available after application. Slowly available nitrogen fertilizers may be divided into two categories: natural organics and ureaform (ureaformaldehyde) compounds.

The cost per pound of nitrogen in a slowly available natural organic fertilizer is about five times the cost per pound of nitrogen in a quickly available fertilizer and two times as expensive as a ureaform nitrogen source. Slowly available nitrogen fertilizers are used for maintenance of turfgrasses because they may be applied in larger amounts of less frequent intervals with less danger of fertilizer burn. High-analysis fertilizers (for example, a 5-10-10 analysis) are usually less costly per pound of plant food than low analysis fertilizers (for example, 10-20-20). High-analysis fertilizers are often applied diluted in water to assure even distribution.

Fertilizer is sometimes combined with pesticides (herbicides, fungicides, and insecticides) for use in turfgrass maintenance. These combinations may be satisfactory if applications of both are needed at the same time. The nutrient content and pesticide content should be adjusted so that each component is applied at the correct rate.

Meeting Soil Fertility Requirements

A complete soil test is the best guide for applying fertilizer and lime. If soils are fertilized according to soil test at the time they are established, there should be no soil deficiencies. Soil-sample forms for turf soils are shown in Problem Area 3. Problem Area 3 also shows a sample Turfgrass Report Form with recommendations for lime and fertilizer.

Soil samples are tested for organic matter, pH, lime requirement, and available phosphorus and potassium. If a soil is low in organic matter, a recommendation to add reed sedge peat or moss peat will be given on the report form.

Fertilizer recommendations for turfgrass establishment are based on the results of the soil test. Fertilizer is applied as "basic" fertilizer and "starter" fertilizer. "Basic" fertilizer, lime, and soil physical conditioners are spread separately but all should be mixed uniformly into the top 4 to 6 inches of soil in one operation. "Basic" fertilizer may consist of phosphate and/or potash materials.

"Starter" fertilizer is a complete fertilizer worked into the top inch of the soil during the final raking operation. It provides the necessary nutrients for the emerging seedlings.

Liming

Soil acidity or alkalinity is a measure of soil reaction and is expressed in terms of pH. The pH-scale indicates the degree of acidity or alkalinity numerically from 0 to 14. A pH of 7.0 is neutral. A pH above 7.0 is alkaline. A pH below 7.0 is acid. When an increase in pH (more alkaline) is desired, calcium and magnesium are added to the soil in the form of lime.

Lime is beneficial for the following reasons:

1. It aids phosphate availability. In acid soils, iron and aluminum may tie up much of the phosphate. When lime is added to raise the pH, the ability of iron and aluminum to tie up phosphates is decreased.

2. It aids soil bacteria. The addition of lime promotes bacterial growth and their beneficial work in the soil. Bacteria are especially active in the decomposition of organic and ureaform fertilizers and grass clippings.
3. It aids disease control. Most diseases of grasses are caused by fungi. Fungi grow best on acid soils. The vigor of the disease-causing fungi is reduced by neutralizing the acidity of the soil.

Turfgrasses grow best in a slightly acid to neutral soil (pH 6.5 to 7.0). The following conditions are found within this range: maximum availability of nutrients, minimum fungal activity, maximum bacterial activity, and optimum grass growth.

Liming Materials

Lime is obtained principally from deposits of limestone rock. There are two basic types of limestone:

1. Calcite - Composed largely of calcium carbonate ($CaCO_3$).
2. Dolomite - Mixtures of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$).

The value of raw ground limestone (calcium carbonate or magnesium carbonate) depends upon its chemical composition and its degree of fineness. Pennsylvania law requires the composition to be expressed as percentages of calcium oxides and magnesium oxides. The combined percentage should be 50 percent or more. Dolomitic limestone is especially useful for soils lacking magnesium.

The rate at which ground limestone reacts with the soil varies with particle size. For turf use, at least 40 percent should pass through a 100-mesh screen, and 98 percent should pass through a 20-mesh screen. Ground limestone is recommended for use on turfgrasses.

Applying Lime

Although grasses will grow in acid soils, they do much better in slightly acid to neutral soils. Lime is applied with a hand spreader on home lawns and other small turf areas. On large turf areas, tractor-drawn spreaders or truck spreaders are used. The supplier may also apply lime as a custom service.

Lime is spread on the surface of the soil and then mixed 4 to 6 inches into the top. On a small area the mixing can be done with a rotovator. Larger areas are mixed with a disk or tractor drawn rotovator.

If the soil test recommends more than 200 pounds of ground limestone per 1,000 square feet, apply one-half of the lime needed and then till the soil. Then apply and mix the other one-half of the lime into the soil when the basic fertilizer is applied.

Applying Basic Fertilizer

A complete soil test includes a recommendation for the amount and grade of fertilizer to apply. Fertilizers should be spread mechanically. There are two basic types of spreaders: the cyclone spreader and the broadcast or seeder spreader. The cyclone spreader distributes the fertilizer in a wider pattern than a seeder spreader. The cyclone spreader applies the fertilizer about four times faster than the seeder spreader. Fertilizer spread with a cyclone spreader during windy weather may drift. The seeder-type spreader applies fertilizer by gravity flow and with the aid of an agitator. The fertilizer is applied closer to the ground; therefore, drift is less of a problem.

Fertilizer spreaders must be calibrated to apply the correct amount of fertilizer. You may wish to review how this is done by reading page 47 and 48.

Fertilizer is applied to golf course fairways or athletic fields with tractor-drawn equipment. For establishment, the basic fertilizer may be broadcast by a truck with a suitable spreading device.

Using Physical Conditioners in Soils

Home Lawns

Organic matter is the most commonly used material for improving the physical condition of the soil in a home lawn. It increases the water-holding capacity and physical condition of the soil. Reed sedge peat or moss peat are better sources of organic matter than manure or sawdust, because they have a longer-lasting effect.

A green-manure crop, such as soybeans or rye, may also be used to add organic matter to the soil. A temporary lawn grass which has been seeded to prevent soil erosion should be turned under approximately 4 weeks before establishing the permanent lawn to allow time for proper decomposition.

Reed sedge peat or moss peat should be added at a rate between 5 to 10 percent by volume of 6-inch depth. The recommended rate will vary with the existing organic matter content of the soil and the type of conditioner used.

In addition to organic matter, coarse amendments are needed to modify soils of high silt, clay, or very fine sand content. The amount of coarse material worked into a soil depends on the physical condition of the topsoil. Coarse sand with particle size ranging from 1/2 to 1 millimeter (approximately 1/25 to 1/50 of an inch) in diameter is most often used for this purpose.

If both peat and sand are used to modify the soil, the peat should be spread first and the sand placed on top. The sand helps to prevent the peat from "floating" to the top during the mixing operation. Moist peat is easier to work into the soil than dry peat.

Added materials should be uniformly mixed into the soil. Each should be spread uniformly over the surface and worked in with a suitable tool such as a garden cultivator, rototiller, or rotary hoe.

Athletic Fields

The turf on athletic fields suffers from soil compaction caused by trampling and by use of heavy maintenance equipment. The addition of sand

and organic materials to the soil will reduce the effects of compaction. These materials are added at the time of construction. Heavy soils may require, by volume, 50 to 60 percent sand and up to 15 percent organic matter for the desired resistance to compaction. These additions amount to 6 to 8 cubic yards of sand and 1 to 3 cubic yards of peat per 1,000 square feet of area. The physical condition of sandy soils may usually be improved by adding 2 to 3 cubic yards of peat per 1,000 square feet.

Mixing the physical conditioners into the soil may be done on or off the site. When mixing is done on the site, the materials should be spread uniformly over the area. Thorough mixing is accomplished by using a rotary hoe, rotovator, or disk. If both peat and sand are used, the peat should be spread first and the sand spread on top.

Off-site mixing is preferred when large quantities of physical conditioners are used. If the soil and modifying materials are run through a soil shredder or mixed in a concrete-type mixer, a more uniform mixture is assured. The soil, peat, and sand are stockpiled at a convenient location and the proper proportions are run through the mixing equipment. Any deficiencies shown by a soil test may be corrected by adding recommended lime and fertilizer during this mixing.

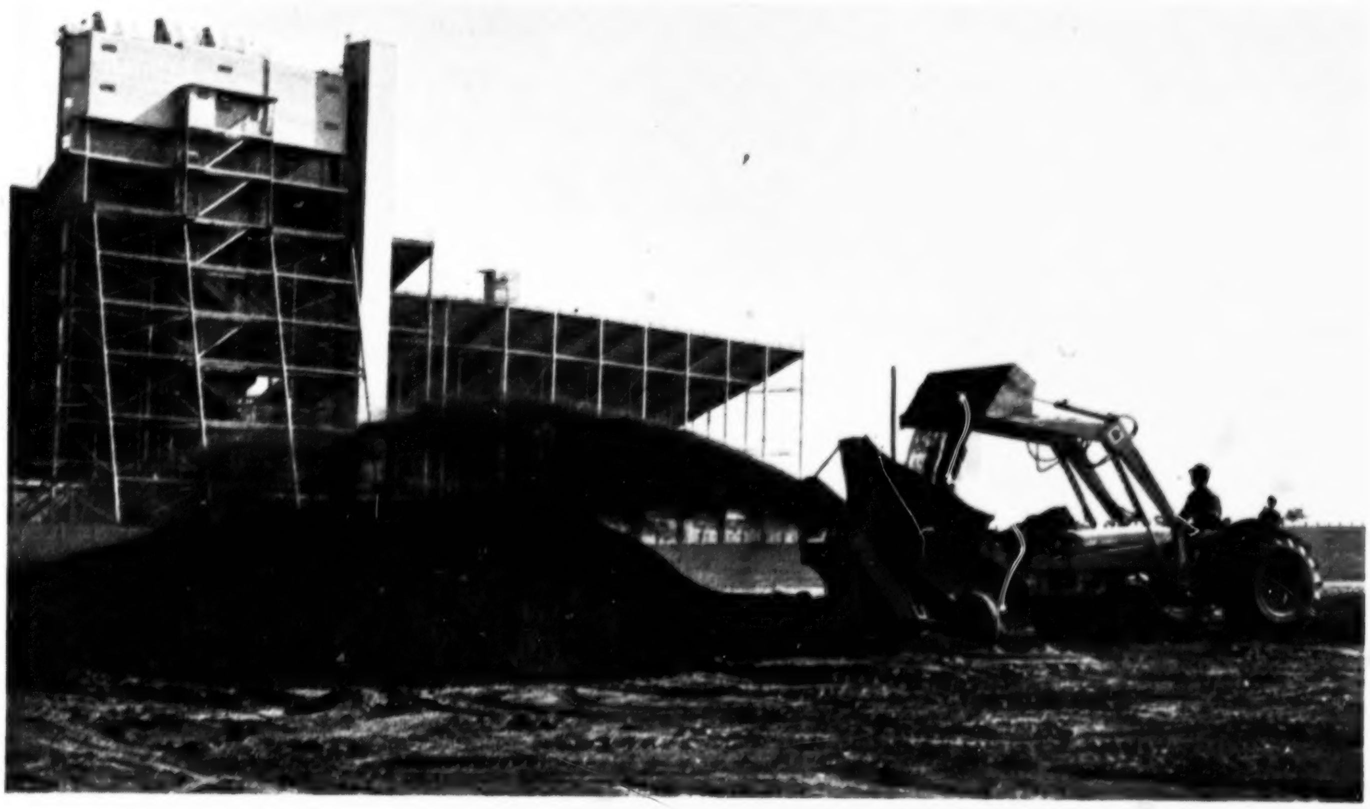


Figure 18. Mixing soil and physical conditioners with a soil shredder.

Golf Greens and Tees

Sand and peat are mixed into the soil to build resilience and resistance to compaction of golf greens and tees. A mixture (ratio) of sand, peat, soil, or other amendments cannot be prescribed to meet all situations. General rules and ranges can be described, but the original soil must be considered in determining the correct ratios for a particular location.

A range of 10 to 20 percent of reed sedge peat or moss peat by volume in the mixture is usually recommended regardless of the proportions of sand and soil. The amount of sand used in a mixture may range from 40 to 75 percent by volume. Sandy soils will require less additional sand, while clay soils will require more.

A rough test of the mixture may be made by puddling a sample into mud pies and allowing them to dry. Those samples which hold together but crumble very rapidly when pressed lightly between thumb and forefinger are usually good soils for greens. Laboratory tests, when possible, are far superior to this test.

The soil, sand, and peat may be mixed on or off the site. Off-site mixing is preferred, because the mixing will be more thorough.

When the base of a green is finished and drain outlets are in place, a ring of soil for aprons and collars is placed around the green. The top 4 to 6 inches of soil used for aprons and collars has the same soil mixture as that used on the green.

The next step is to fill the depression with 14 to 16 inches of soil mixture prepared off the site. Boards are placed on the aprons to prevent any disturbance by vehicles used to transport the soil. A small crawler tractor may be used to distribute the soil mixture.

Grade stakes are helpful in indicating the depth of the mixture. After the soil mixture has been spread evenly it should be allowed to settle. Repeated tamping and raking will result in a firm seedbed. Water can be used to settle the surface. This practice may also reveal any water-holding depressions in the soil. Whenever amendments are used to alter the physical condition of the soil, it is necessary to adjust maintenance practices.

Amended soil dries less rapidly than the original if the original soil was sandy. It dries more rapidly if the original was clay. The amended soil will retain fertilizer better than the original if the original was sand. However, amended soils will leach fertilizer more rapidly than the original soil if the original was clay.

Preparation for Seeding

Areas where a new turf is to be established should be plowed and tilled to prepare the soil. Basic fertilizer, lime, and soil physical conditioners should be spread over the area. These materials should be mixed uniformly into the topsoil with a disk, cultivator, or rotary hoe. High-speed rotary tillers are not usually recommended for tilling the soil. They tend to destroy soil structure by their beating action.

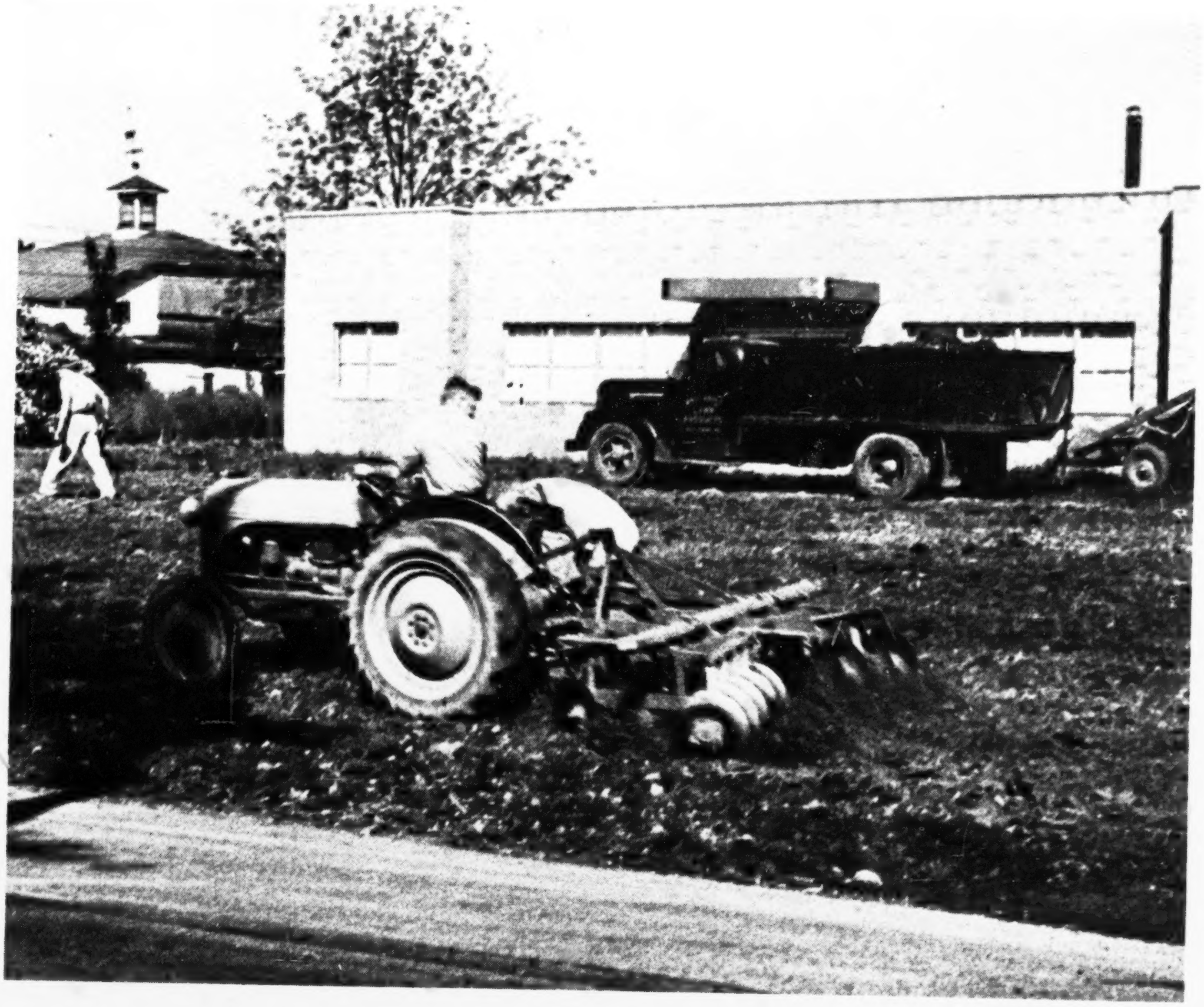


Figure 19. Disking aids in preparing the seedbed for new turf areas.

A drag or smoothing harrow is pulled across the area to break up lumps and to smooth the surface for seeding. Harrowing should be done with as many passes, each from a different direction, as are needed. To allow for settling, tilling should be completed 7 to 10 days in advance of the recommended seeding date. Hand raking is needed for final smoothing of the surface.

Applying Starter Fertilizer

Seeding grasses have shallow root systems during their early development. It is important to have an adequate supply of nutrients in the top layer of soil during this early period of growth. The starter fertilizer is complete fertilizer spread over the seedbed and is mixed into the top inch of the soil during the finish raking.

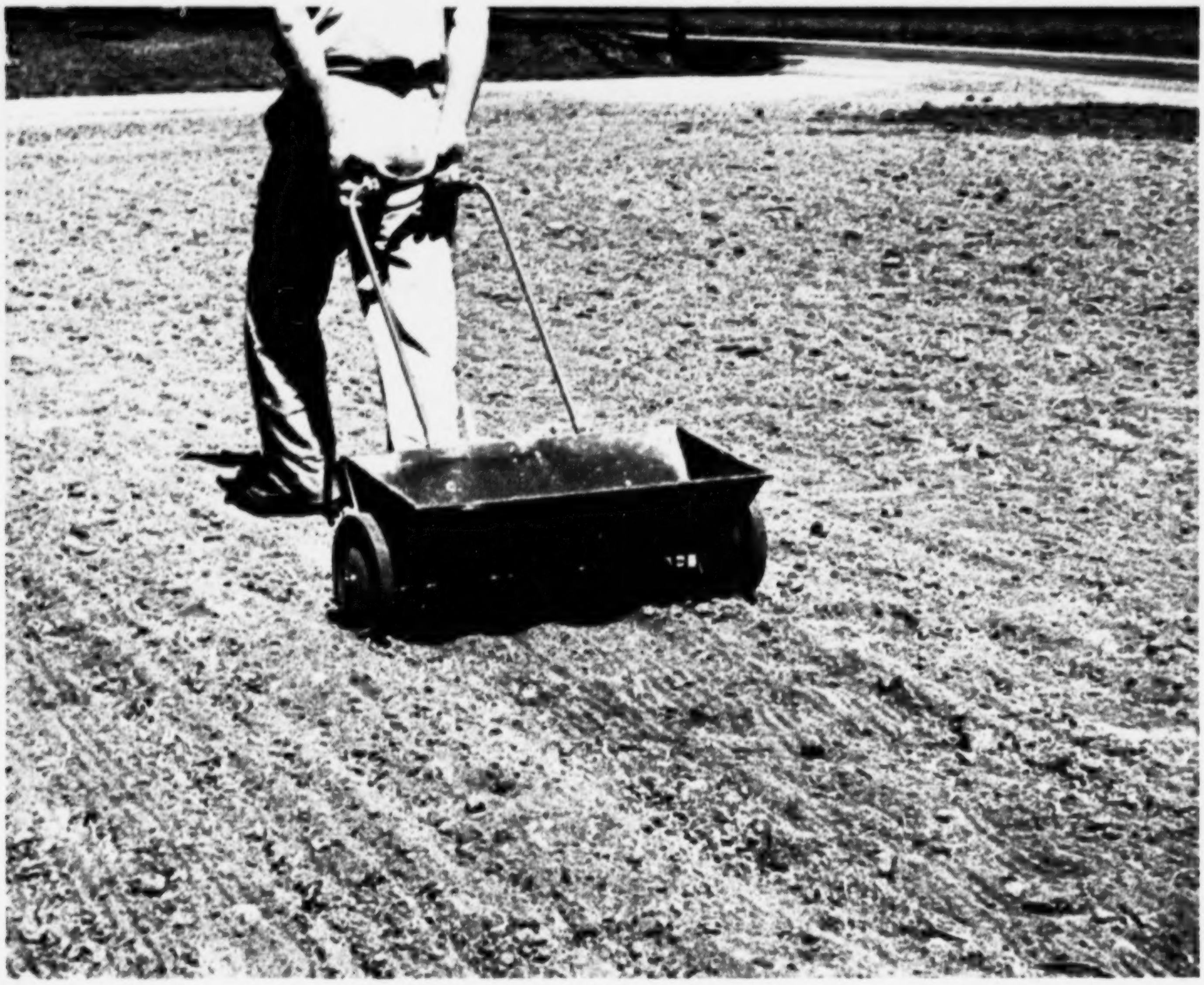


Figure 20. Starter fertilizer is spread over the seedbed prior to finish grading.

Finish Grading

Finish grading is designed to smooth uneven spots. Hand raking is used on small areas. Harrows and drags are used on larger areas.

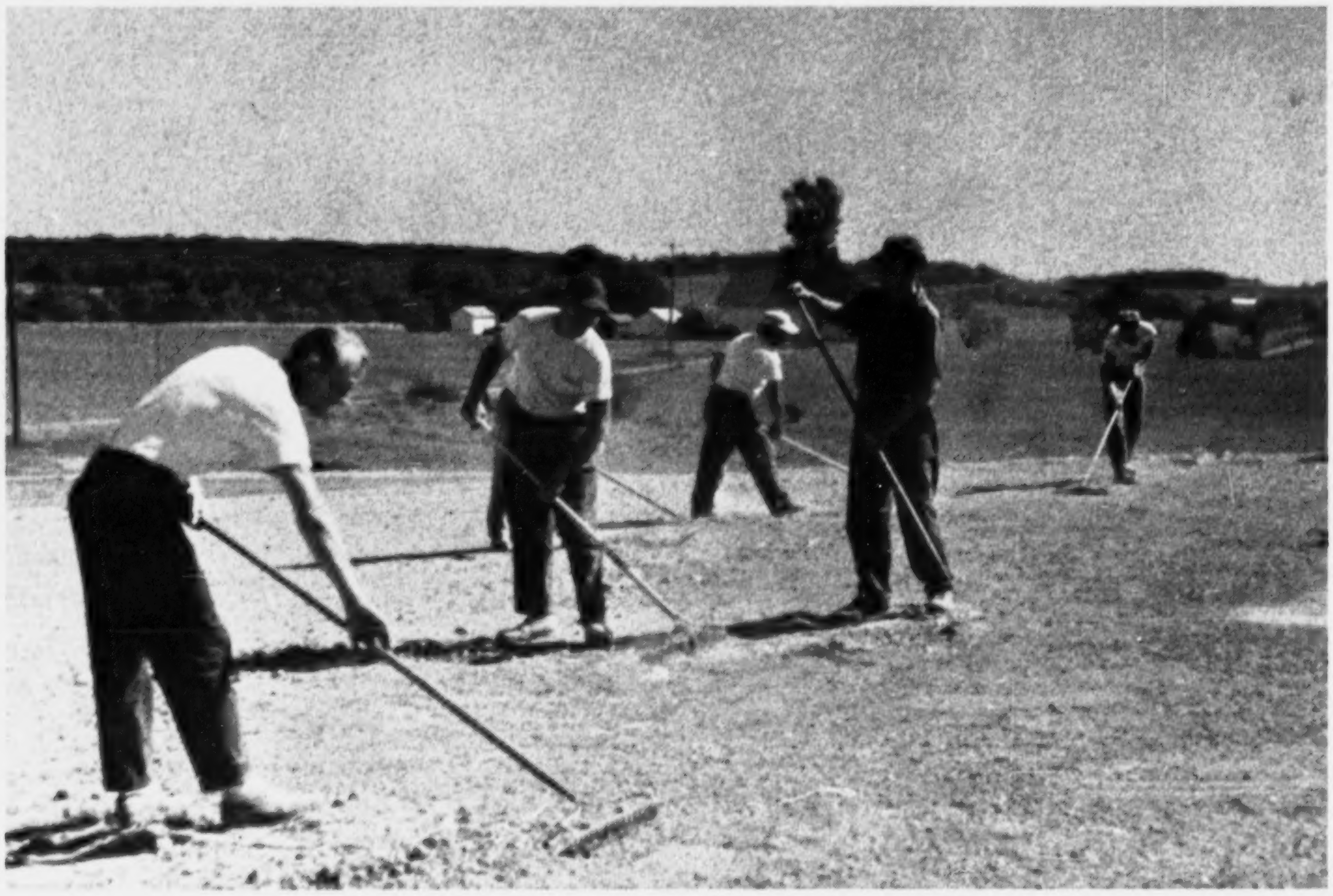


Figure 21. Finish grading by raking smoothes the seedbed, removes stones, pulverizes the soil, and mixes starter fertilizer.

Selecting Kinds of Grasses and Grass Mixtures

In the establishment of a new turf area, the selection of the right kind of grass mixture becomes a critical part of the planning procedure. Although small turf areas are sometimes planted with sod, or sprigs, most lawns are started from seed. A knowledge of different species of turfgrasses and their characteristics is necessary to select the right kind for the area to be planted.

When the site has varied soil type, sun, and shade, mixtures of turfgrasses give a better turf. Most commercial mixtures are adapted to a variety of conditions such as exposure to sun and shade. Table 1 lists the suggested mixtures and seeding rates for Pennsylvania. Whenever possible, use blue-tag certified seed.

Table 1

Suggested Mixtures and Seeding Rates for Pennsylvania Turf Areas

A. Home Lawns, Cemeteries, Industrial and Institutional Grounds*	
1. Open, sunny locations	
a. Merion Kentucky Bluegrass	35 - 60%
Kentucky Bluegrass (Common, Prato, Delft, Newport, Fylking, Cougar - Use two or more of these varieties in the mixture)	40 - 65%
(seed at 3-4 lbs. per 1,000 sq.ft.)	
b. Pennlawn Red Fescue	35 - 60%
Kentucky Bluegrass (Merion, Common, Prato, Delft, Newport, Fylking, Cougar - Use two or more of these varieties in the mixture)	40 - 65%
(seed at 3-4 lbs. per 1,000 sq.ft.)	
2. Heavy shade	
a. Pennlawn Red Fescue	60 - 70%
Rough Bluegrass (Poa trivialis)	30 - 40%
(seed at 4 lbs. per 1,000 sq.ft.)	
3. Moderate or partial shade	
a. Pennlawn Red Fescue	50 - 60%
Kentucky Bluegrass (Merion, Common, Prato, Delft, Newport, Fylking, Cougar - Use two or more of these varieties in the mixture)	15 - 25%
Rough Bluegrass (Poa trivialis.	15 - 25%
(seed at 4 lbs. per 1,000 sq.ft.)	
B. Heavy-duty Turf Areas (Athletic fields, parks, and playgrounds)	
1. Kentucky 31 Tall Fescue	100%
(seed at 6-8 lbs. per 1,000 sq.ft.)	
2. Kentucky Bluegrass (Merion, Common, Prato, Delft, Newport, Fylking, Cougar - Use two or more of these varieties in the mixture)	40 - 65%
Pennlawn Red Fescue	35 - 60%
(seed at 4-5 lbs. per 1,000 sq.ft.)	
C. Temporary Turf Areas (Quick temporary cover for erosion control)	
1. Common Ryegrass	100%
(seed at 4-5 lbs. per 1,000 sq.ft.)	

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* 3-5% Redtop or 15-20% Norlea or Pelo ryegrass may be added to these mixtures to give quick cover for fall or late spring seedlings. They are also used in mixtures for seeding sloping areas.

D. Special Areas (Highways, slopes, banks, dams, and levees)

1. Mowed areas
    - a. Kentucky 31 Tall Fescue 100%
      (seed at 4 lb. per 1,000 sq.ft.)
    - b. *Kentucky 31 Tall Fescue 50%
      Pennlawn Creeping Red Fescue 25%
      Common Kentucky Bluegrass 25%
      (seed at 2½ lb. per 1,000 sq.ft.)
2. Non-mowed areas
    - a. Penngift Crownvetch 25%
      Kentucky 31 Tall Fescue
      or
      Creeping Red Fescue
      or
      Perennial Ryegrass 75%
      (seed at 1½ lb. per 1,000 sq.ft.)
    - b. Kentucky 31 Tall Fescue 100%

E. Golf Course Greens

1. Penn Cross Bentgrass 100%
   (seed at 1 lb. per 1,000 sq.ft.)

Regulations Governing Grass Seed Sales

Laws of many states require that certain information be provided with or on the grass seed container. The following are the main points of the regulations governing grass seeds sold in Pennsylvania:

1. Grasses are to be classified into two texture groups:
    - a. Fine texture - Velvet, creeping and colonial bluegrass; Canada, wood, rough, and Kentucky bluegrasses; sheep, creeping red, and Chewing's fescue.
    - b. Coarse kinds - All others not included in fine texture group.
2. Seeds of all plant species or varieties exceeding 5 percent of total mixture must be named, except redtop and white clover.
3. Each species or variety in the mixture (except redtop and white clover) must be listed as a percentage of the total weight if it exceeds 5 percent.

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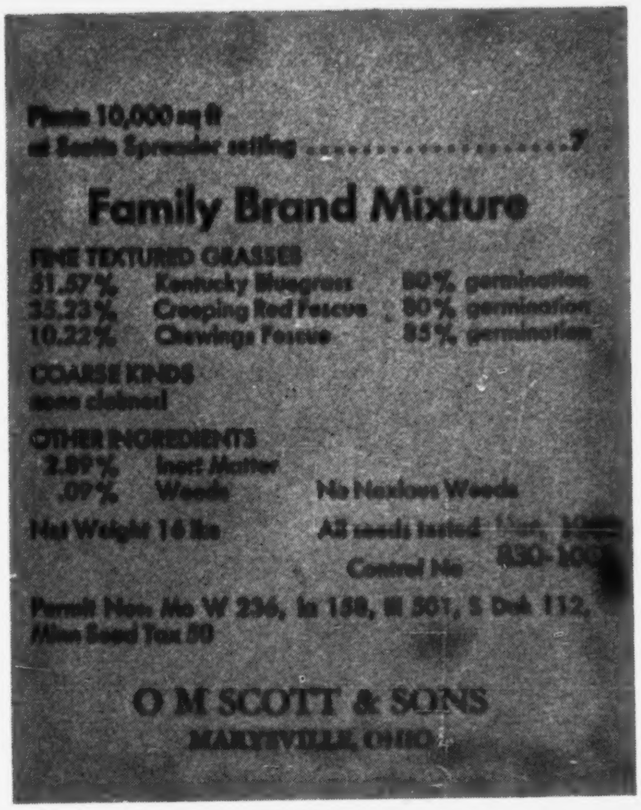
*This is the Pennsylvania Department of Highways mixture for mowed highway areas. It is the only mixture contractors are permitted to use.

4. Date of the germination test with percentage of germination for each species or variety must be included.
5. Other factors must be listed:
   a. Weight, by percent, of weed seeds. This should not exceed one-half of one percent of the total weight of the mixture.
   b. Weight, be percent, of other agricultural crop seed. This includes all crop seed occurring in amounts of 5 percent or less with the exception of redtop and white clover which may be listed in lesser amounts.
   c. Weight, by percent, or inert matter such as chaff.
   d. The name and number of noxious weed seeds.


Plants 10,000 sq ft
at Scotts Spreader setting 7

Family Brand Mixture

FINE TEXTURED GRASSES

51.57%	Kentucky Bluegrass	80% germination
35.23%	Creeping Red Fescue	80% germination
10.22%	Chewings Fescue	85% germination

COARSE KINDS
none claimed

OTHER INGREDIENTS

2.89%	Inert Matter	
.09%	Weeds	No Noxious Weeds

Net Weight 16 lbs
All seeds tested [illegible]
Control No 830-100

Permit Nos. Mo W 236, Ia 158, Ill 501, S Dak 112, Minn Seed Tax 50

O M SCOTT & SONS
MARYSVILLE, OHIO

HOUT'S PENN STATE
LAWN GRASS MIXTURE

%		% Germ
	Fine Textured Grasses	
49.21	Pennlawn Fescue	88
37.40	Kentucky Bluegrass	80
	Coarse Kinds	
5.58	Red Top	85
	Other Ingredients	
.11	Crop Seeds	
7.22	Inert Matter	
.48	Weeds	

Lot No. 5107
Tested June 1968

Figure 22. Sample seed tags.

Pure and mechanically clean seed of desirable turfgrasses is available from many sources. When selecting seed, always check the purity of the species and percentage of germination. Table 2 reports the minimum standards for purity and germination.

Table 2

The Minimum Percentages for Purity and Germination of Turfgrass Seeds

Species	Purity (%)	Germination (%)
Kentucky Bluegrass	85	75
Merion Kentucky Bluegrass	90	75
Pennlawn Fescue	98	85
Kentucky 31 Fescue	98	85
Rough Bluegrass	90	80
Redtop	92	85
Ryegrass	95	90
Penngift Crownvetch	98	70*
Colonial Bent	95	90

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*Up to 35% hard seed permitted.

Selecting Seeding Dates

August and September are the best months to seed a new turf area in the Northeast. Early August sowing is appropriate for northern New England, while a late September sowing would be best for Virginia. During these periods there is usually a good supply of moisture and the hot weather of summer is past. Fewer annual weeds germinate at this time of year. Grass seedings made in early fall become sufficiently established to begin rapid growth in the spring.

If seeding must be done in the spring, it should be done as early as soil conditions permit. However, soil should never be worked when it is saturated with moisture. Early seeding takes advantage of the cool moist conditions which promote good root development. Nevertheless, spring seedings usually suffer from competition with crabgrass and many other weeds that normally germinate in the spring.

Seeding during June and July is usually less successful than in spring or fall, because the seedlings do not grow rapidly in hot weather. Also, maintaining adequate moisture levels in the upper soil layers for the young grass plants is often very difficult during this period.

Seeding

Any seeding method which distributes the seed at a uniform and correct rate is satisfactory. Small areas may be seeded by hand or by several types of mechanical seeders especially designed for home lawns.

Cultipacker seeders, grass seed drills, hopper distributors and cyclone seeders are available for seeding large areas. Cyclones seeders and hopper distributors place the seed on the surface of the soil. They require a second operation to cover it. The cyclone seeder distributes the seed by throwing it horizontally over the ground. This type of seeder does not work satisfactorily with mixtures, because the heavier seeds are thrown farther than the lighter seeds causing strips or patches of different grasses.

Seed separation in the hopper of the seeder can be a problem when seed mixtures are applied. Small seeds settle to the bottom and are spread before the large seeds. When settling out is a problem, each size seed should be sown separately or a spreader with a divided hopper should be used.

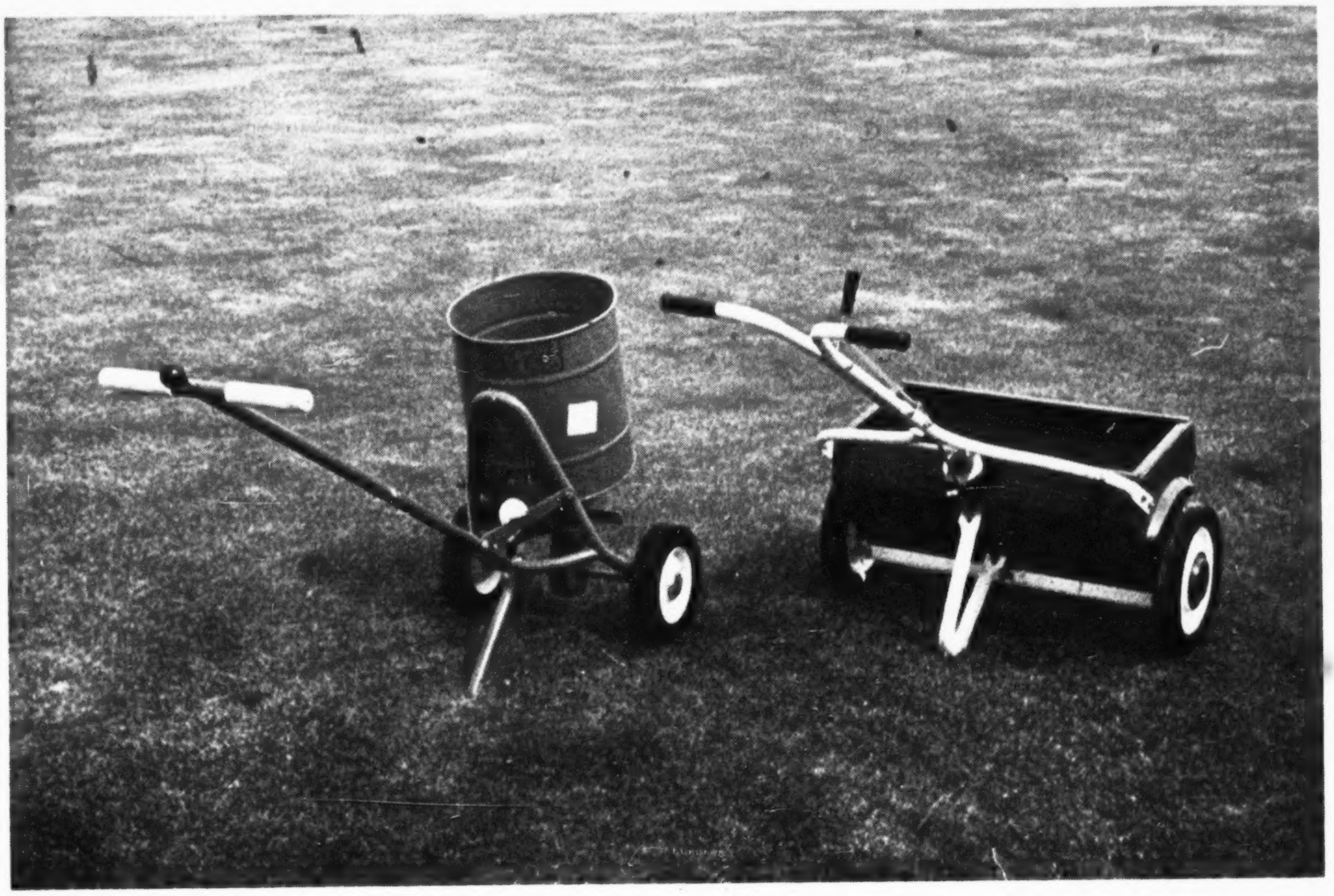


Figure 23. The broadcast seeder-spreader, left, and hopper seeder-spreader, right, may be used for sowing seeds (or for spreading fertilizer).

An equal amount of finely screened topsoil or sand may be mixed with the seed to help obtain uniform distribution. However, the seeder should be calibrated to account for the added soil or sand. The seed should be divided into two equal parts. Broadcast the first portion over the entire area. The second portion of seed should then be broadcast in a pattern at a right angle to the first broadcast pattern.

Some people with considerable experience in sowing grass seed feel that no mechanical device is entirely satisfactory for sowing mixtures of seeds. They prefer to sow by hand to assure an even mixture of kinds of grass species in the area planted. Sowing by hand can only be done effectively in calm air. One-half the seed for the area is sown across the area in one direction, and the remaining half is then sown at right angles to the original direction. One handful of seed is sown at a time in a broad, sweeping motion of the arm, as the worker walks across the area to be sown. In effect, the seed is flung into the air in a broad swath, and settles to the ground in a broad pattern. A wind will distort the pattern. The second pass is made to assure even seed distribution over the area.

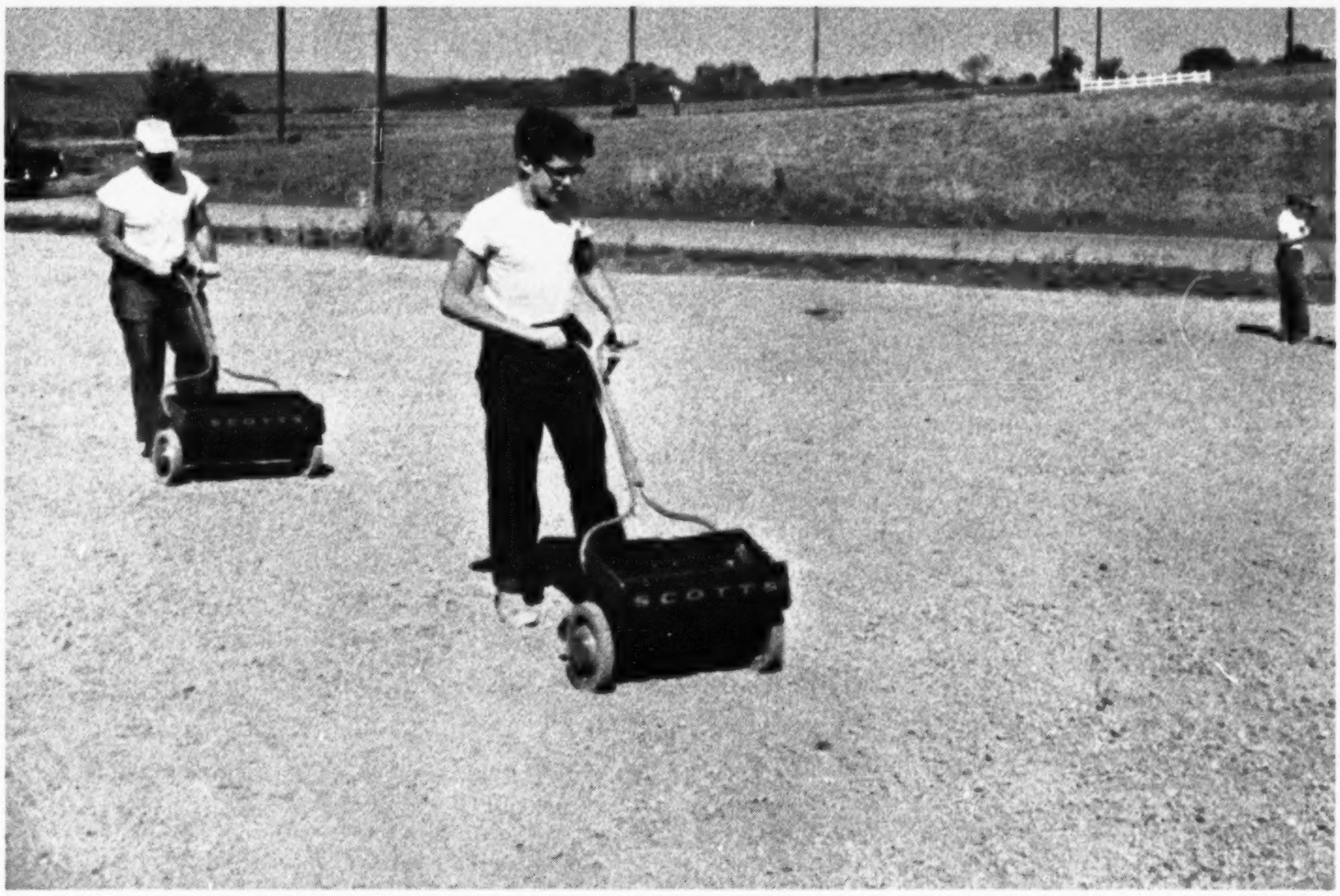


Figure 24. Seeding a new lawn on a finely prepared seedbed.

Covering Seed

On small areas, seeds can be covered by very light raking. A flexible lawn rake can be dragged over the seeded area. For large areas a chain harrow or length of heavy fencing wire may be used.

It is most important that the seeds are not too deeply covered. A 1/8 inch covering is enough for small seeds and 1/4 inch should be the maximum for larger seeds.

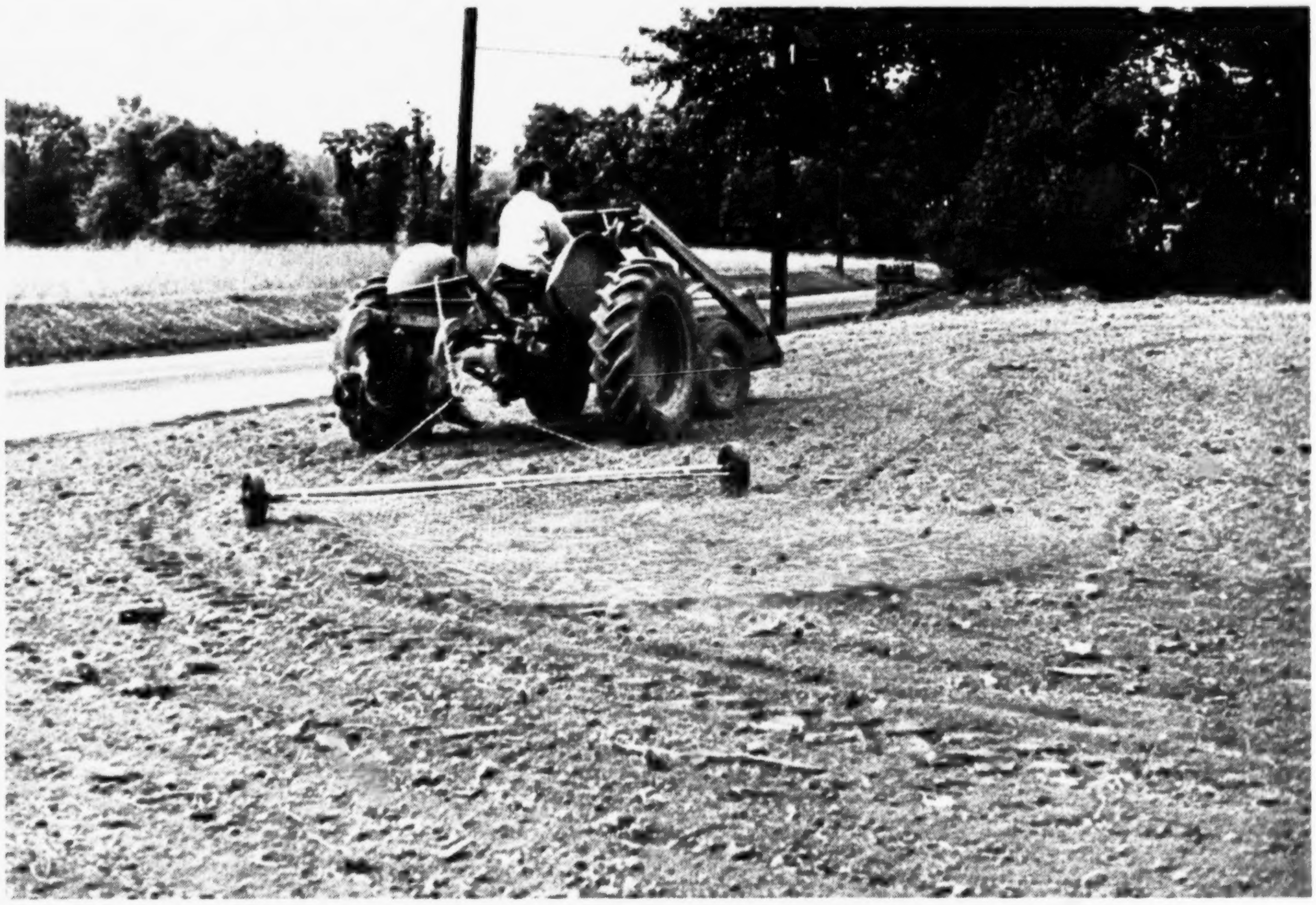


Figure 25. Covering the seed with a drag made from heavy fencing.

Rolling

To firm the soil around the seed, light rolling should follow the covering operation. Soil will be compacted if the roller is too heavy. A cultipacker seeder distributes the seeds, covers the seeds, and rolls the seedbed in one operation. However, rolling after the mulch is in place helps anchor the mulch to the soil.

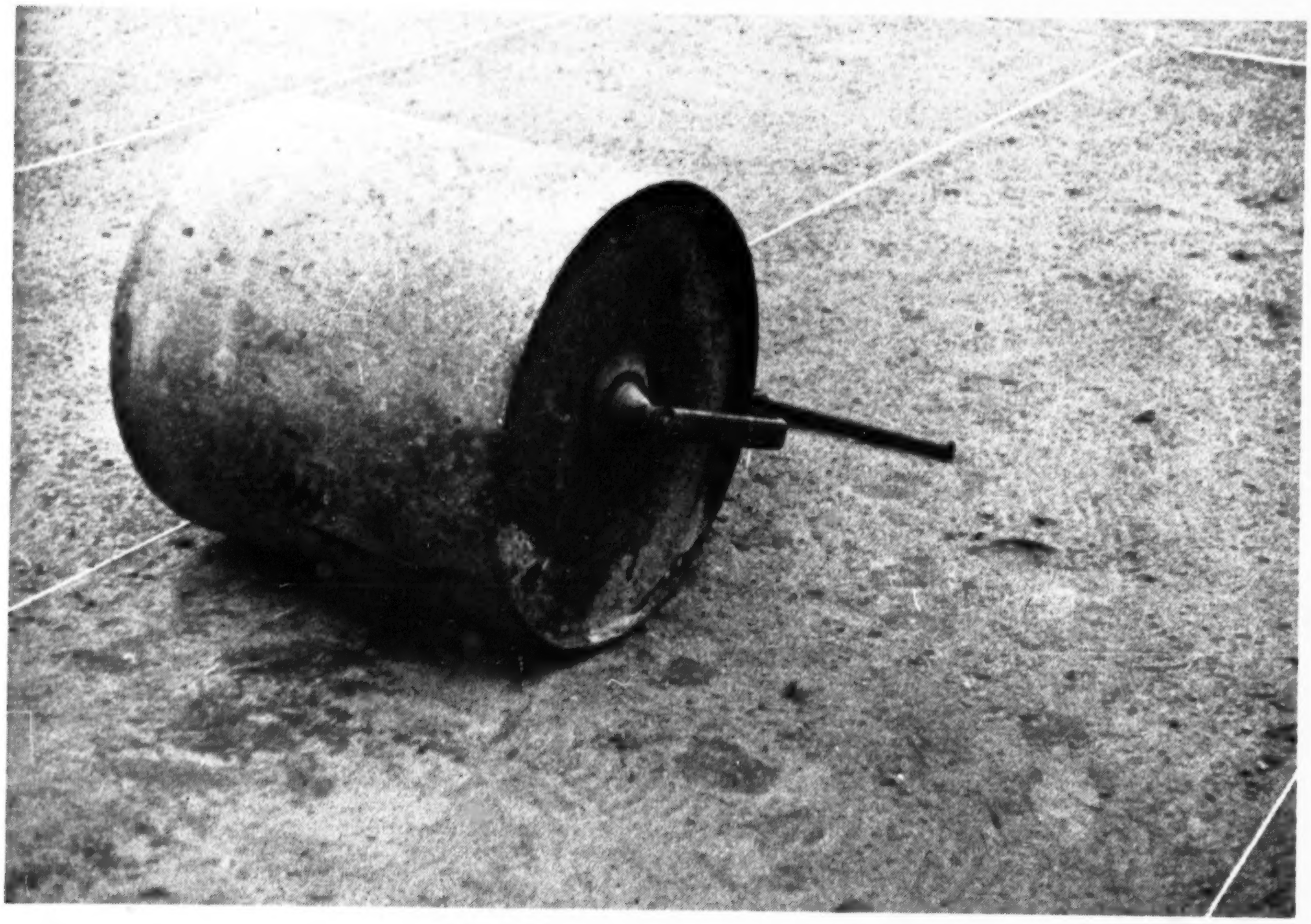


Figure 26. Rolling places the seed in firm contact with the soil. Note that water may be added to this roller through the opening in the end if additional weight is needed.

Mulching

Straw for mulching is spread over the seeded area one-fourth inch deep. From 75 to 100 pounds of straw will cover an area of approximately 2,000 square feet. On small areas a pitch fork may be used to shake out the straw thoroughly. After the straw is spread, approximately two-thirds of the soil surface should be visible. The loose straw may be tied down with a system of stakes and string to prevent the wind from blowing it away. Light netting, made especially for this purpose, may be used. The straw may also be lightly sprayed with asphalt emulsified in water to hold it in place.

In some cases, a much heavier layer of straw or hay is used to promote quick germination. When heavy mulch is used, half of the mulch should be removed as soon as the seeds germinate. The other half should be removed when the seedlings are 1/2 to 1 inch high. A broom rake is a good tool to use when removing the straw or hay mulch. Care must be used to prevent pulling the young seedlings out of the soil.

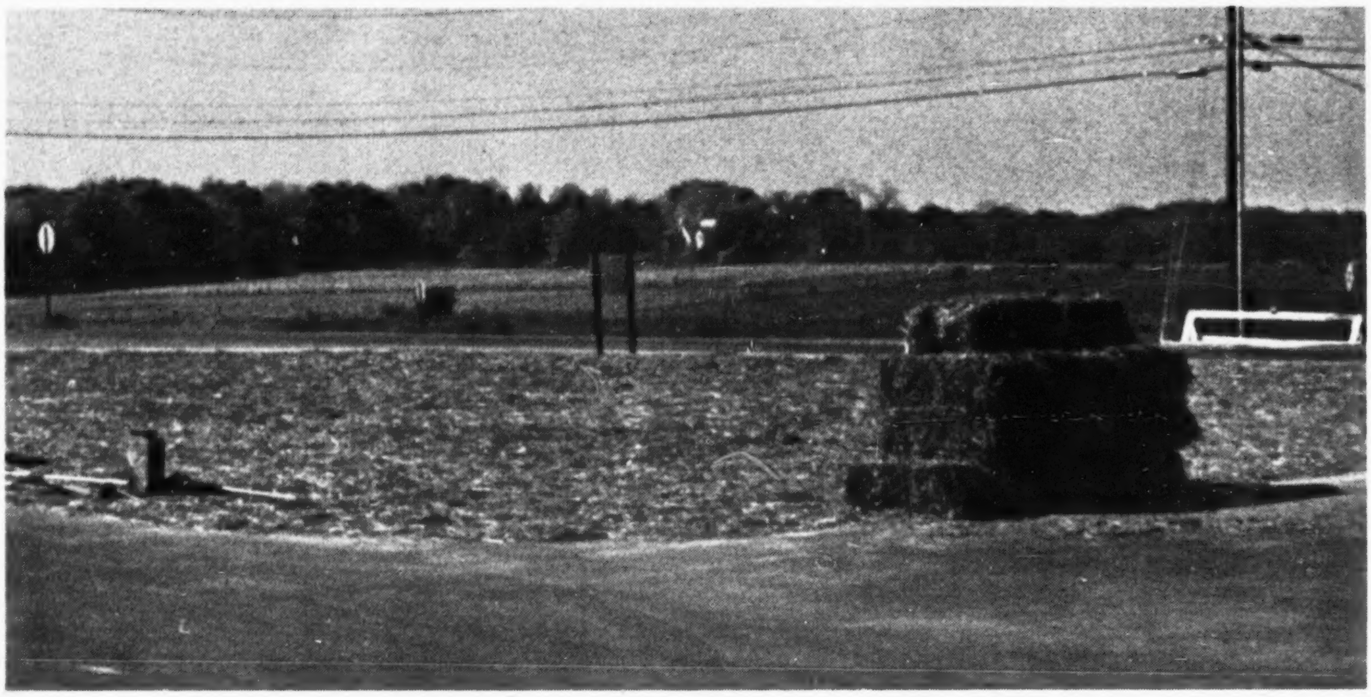


Figure 27. Straw mulch has been applied after seeding to prevent erosion and reduce evaporation of soil moisture.

More recently, liquid latex substances are being used in mulching. A thin film latex is sprayed over the newly seeded area to protect the new seedlings from heavy rains and drying winds. There must be sufficient moisture in the soil for germination prior to spraying. The cost of the latex material is approximately $3.00 per 1,000 square feet. Special equipment is needed to apply it.

Cheesecloth and loose burlap also may be used as mulch. If they are used, they must be removed as soon as a seed germinates. There is less shock to the seedlings if mulch is removed on cloudy or rainy days.

After the mulching material is in place, the entire area must be watered. Latex mulches must be thoroughly dry before water can be applied.

Vegetative Planting

Soil preparation and fertilization is the same for vegetative plantings as it is for seeding.

Sprigging

"Sprigging" is planting runners, stolons, or individual plants at intervals throughout the area. This method is used with certain types of bentgrasses. Established sod is shredded or torn apart to obtain these sprigs or runners.

Other varieties of creeping bentgrasses are propagated by broadcasting stolons over the prepared soil. This method is the most common method for planting golf greens. Eight to ten bushels of stolons are required per 1,000 square feet.

Rolling presses the stolons into the surface of the seedbed. The area is then topdressed with about one-half cubic yard of soil mixture per 1,000 square feet. This topdressing mixture is the same as that described for seed beds on page 129. After topdressing,the area should be rolled again. The new planting is then watered.

All vegetative plantings must constantly be kept moist until the grass is well established.

Sodding

Sodding is used when complete coverage is needed immediately. Scuffed portions of athletic fields may be sodded. Many home lawns are now being established by sodding. Slopes are often sodded to give immediate erosion control.

Good quality sod increases the chance of successful establishment, because it is dense and well knit. It is free of weeds, insects, and diseases. The wholesale price of sod is approximately 5 to 10 cents per square foot. When sod is installed, the rate is 10 to 14 cents per square foot, depending on the installation problems.

Soil preparation and fertilization are the same for sodding as for seeding.

The sod is usually cut in strips 12 to 18 inches wide and in lengths convenient for handling (4 to 6 feet). Sod should be cut uniformly. Sod cutting machines are available to handle large jobs easily. Small areas of sod can be cut satisfactorily with a hand tool called a sod lifter. A board 10 to 12 feet long and 12 inches wide may be used as a guide for cutting. Hand cut sod should be trimmed to uniform size and thickness (1/2 to 3/4 inch).

A device may be constructed to trim sod to the size desired by nailing wood strips onto a plank. The pieces of sod are placed on the frame with the grass side down. Any excess grass, roots, and soil should be trimmed off with a suitable sharp tool such as a scythe blade. The tool will ride on the sides of the frame.

The pieces of sod are laid in a brick-like pattern to eliminate continuous joints. Laying the sod at a right angle to the slope will prevent washouts if heavy rain occurs. As soon as the first row of sod is in place, a board may be laid on the sod to support the person laying the next row of sod. The sod is tamped lightly after it has been laid. A small amount of topsoil is worked into the cracks between the pieces of sod with a broom or the back of a broom rake. Rolling sod is not recommended because the strips of sod tend to slip under the roller and cause gaps and overlaps at the joints. Thorough watering at 2- to 3-day intervals is essential until the sod is established. Sod establishment may take 3 weeks.

Caring for New Grass

Water is most important for obtaining a good stand of grass. The soil should be kept evenly moist until grass has germinated and the plants are established. After the seeds have swelled, the surface should not be allowed to become dry until the roots have developed. A mulch shades the soil and prevents it from rapid drying.

The first application of water should be carefully and finely sprayed to prevent washing the seed away. The amount and frequency of watering will depend upon the soil and season. If the weather is dry, it may be necessary to water daily for about 3 weeks. During the fourth through sixth week, watering every 2 to 3 days should be adequate. After the grass is 3 inches high, thorough watering should be made weekly.

When the new grass reaches a height of 1/2 to 1 inch, the mulch should be removed. Removal must be done carefully or the young seedlings may be pulled from the soil. The young seedlings may die from lack of light if the mulch is not removed. A pitch fork or flexible lawn rake may be used to remove the mulch. It is not necessary to remove every stem of straw, but most of it should come off. If only a light mulch of straw was used, it may be left in place. The new grass will completely hide it in about 6 weeks.

The new lawn should be mowed as soon as it becomes 2 to 3 inches high. A sharp mower set at the correct height of cut for that particular grass is very important. A dull mower will pull the seedlings out of the ground. Bluegrass and fescue lawns are mowed at a height of 1½ to 2 inches. Not more than 1/4 to 1/3 of total leaf surface should be removed at any one mowing. Mowing should continue until the grass stops growing in the fall.

Renovating Old Turf Areas

When an old turf is in poor condition, you must first find out the cause or causes of this condition. Before renovating a poor quality turf, examine the causes of this condition. Then decide whether complete reconstruction or simple renovation is best. Reconstruction, or renovation, is best done in late spring or early fall when the growth is rapid. In many cases, however, it may be necessary to do something as soon as the condition is recognized.

There are two situations which demand complete reconstruction: (1) if poor drainage is causing poor growth, and (2) if over 50 percent of the grass is undesirable.

Bentgrass in a Kentucky Bluegrass lawn or Bermudagrass in a golf course green is a serious weed. If there is poor drainage, tile drainage should be installed or surface pockets of water should be eliminated by regrading. When there are undesirable species, an appropriate chemical should be applied to kill all plants. The dead plant material should then be plowed under the soil, a new seedbed prepared, and a new sowing made.

If less than 50 percent of the grasses are undesirable, renovation is appropriate. Renovation is also appropriate if the cause of poor growth is low fertility, low pH, disease, insect injury, weed invasions, soil compaction, thatch accumulation, or improper care.

If thatch accumulation is a problem the thatch should be cut by a vertical mower and removed. A vertical mower is a special machine with blades that cut into the turf vertically. The depth of cut is adjustable.

If compaction is a problem, an aerator should be passed over the area 4 to 6 times in different directions. After aerating, a light application of pulverized peat as a topdressing will help overcome the compaction problem.

If fertility is a problem, lime and fertilizer applications based on soil tests should be made. If grubs or other soil insects are a problem, chlordane should be applied at the same time as the fertilizer. These materials should be lightly worked into the soil by dragging a tine harrow or a piece of heavy wire fencing over the area. After the fertilization is completed, the seed should be covered by raking. Reseeding is done at the rate for a new lawn. The renovated area should then be lightly rolled and watered. Frequent light watering is necessary until the new grass plants become established.

If insects and diseases of the tops of the plants have been a problem, appropriate pesticides should be applied after the new grass has become established. Herbicides should not be applied until 6 months after reseeding. Young grass plants can be severely injured by herbicides that are relatively harmless to older grass.

Test

1. The grade requirements of a turfgrass area are determined by:
    a.
    b.
    c.
2. Why are materials left from construction removed by final grading?
3. Why is good drainage so important?
4. List factors to consider when designing and installing irrigation systems.
5. What is the purpose of mixing sand and organic matter in the topsoil?
6. Explain the difference between slowly available nitrogen fertilizer and quickly available nitrogen fertilizer.
7. What is the recommended form of lime to use on turfgrass areas?
8. Why are mixtures of turfgrass seeds used, rather than pure seeds of a single species?
9. When is the best time to seed a new turfgrass area?
10. In what ways does mulch aid in establishing the grasses?
11. Why is it important to remove and stockpile the topsoil on a new construction site?
12. Why do fertilizer costs vary?
13. Describe how to check the calibration of a fertilizer spreader.
14. What is the purpose of a starter fertilizer?
15. Why is crushed stone base used in constructing a golf green?
16. Why is it sometimes necessary to add modifying materials to topsoils?
17. Why is it important to thoroughly mix lime, basic fertilizer, and soil physical conditioners into the topsoil?
18. Why is it important to cover seed and roll the seedbed lightly?
19. Which grasses are established by vegetative planting?
20. When would sod, rather than seeding, be used to establish a turf?
21. Describe how to apply a straw mulch to a newly seeded area.
22. When and how should the straw mulch be removed?
23. What factors determine when a turfgrass area needs to be renovated?
24. What determines the frequency of mowing?
25. What determines the frequency of irrigation?

SUGGESTIONS AND REFERENCES FOR THE TEACHER

Learning Resources

References:

Approved Practices in Beautifying Home Grounds. Reference No. 1.

Athletic Fields. Reference No. 2.

Better Lawns. Reference No. 3.

Fall Renovation of Greens and Fairways. Reference No. 9.

Home Lawns. Reference No. 13.

Peats and Organic Materials for Soil Modification. Reference No. 16.

The Lawn Book. Reference No. 22.

The Lawn Book. Reference No. 23.

Turf Management. Reference No. 27.

Turfgrass Establishment. Reference No. 24.

Turfgrass Guide for Lawns, Recreation Areas, and Roadsides. Reference No. 25.

Supplies:

1. samples of tile, gravel, and other materials
2. samples of fertilizer, including: natural organics, ureaform, phosphate, and potash materials
3. samples of organic materials, such as moss peat
4. samples of turfgrass seeds and seed mixtures
5. samples of stolons, plugs, and sod used in vegetative planting
6. rotary tiller or other mechanized equipment used for leveling and seedbed preparation
7. garden spades, rakes, and other hand tools used in turfgrass establishment
8. fertilizer and seed spreaders
9. seeds, fertilizer, lime, mulching materials, and other materials necessary to establish turfgrass plots

Audio Visual Aids:

"Beautiful Lawn," 21 minute color film, The National Plant Food Institute, 1700 K Street NW, Washington, D. C. 20006.

"Turf Care," 17 minute color film, Association Films, Inc., 600 Grand Avenue, Ridgefield, New Jersey 07667.

"Turfgrass Identification," a series of 2" x 2" color slides, Department of Agricultural Education, The Pennsylvania State University, University Park, Pennsylvania. Price $5.00.

Suggested Student Learning Activities

Prior planning is essential to success in establishing a new turfgrass area. Many factors are used to assess a site to determine the procedures to follow. A complete plan should be developed before any construction work is to begin. A schedule for construction may be developed using the following outline:

Construction Operation	Beginning Date	Ending Date
1. Removal and stockpiling of topsoil		
2. Rough grading		
3. Installation of irrigation and drainage systems		
4. Return of topsoil		
5. Seedbed preparation		
6. Seeding		

1. Test the students on the steps necessary to establish a turfgrass area. Use the test results to emphasize the importance of advanced planning.
2. Plan a tour of local homes where preparations are being made to establish new lawns. Examine the grading and drainage practices being used.
3. Bring samples of fine and coarse sand, reed sedge peat, moss peat, and clay soil to the classroom. Discuss the uses of each modifying material. Using dry samples, place an equal quantity of clay soil and sand in pots of the same size. Slowly pour equal quantities of water into each pot. Collect and measure the amount of water that drains from each pot. Note how the clay soil puddled, but absorbed much of the water. The sand absorbed little of the water, but did not puddle. Dump the soil from each pot into a separate pile and press it into a ball. Note how the clay forms a sticky lump, whereas the sand tends to fall apart.

   Prepare mixtures of soil, sand, and peat in the following proportions:
   - Mixture #1 - 1 part sand, 1 part soil, and 1 part peat
   - Mixture #2 - 2 parts sand, 1/2 part soil, and 1/2 part peat
   - Mixture #3 - 1 part sand, 1 9/10 parts soil, and 1/10 part peat
   - Mixture #4 - 3 parts sand, 1/2 part soil, and 1/2 part peat

Follow the procedure given on the preceding page to demonstrate the water-holding capacity of each mixture. Puddle the wet mixtures and allow them to dry. Compare the mixtures with the dried lump of clay and with the dried sand noted previously. Note how the mixtures appear to be the most satisfactory plant-growing medium.

4. Examine samples of fertilizers noting the physical form (granular, powdered, and pelleted). Discuss grade, composition (organic vs. inorganic), costs per pound of plant food, combinations of plant food, combinations of fertilizer and pesticides.
5. Display labeled samples of lawn grass seeds and grass seed mixtures. Note differences in seed size. Learn to identify individual grasses by examining sod plots and by using the 2" x 2" color slide series "Turfgrass Identification."
6. Plan a field trip to an athletic field or golf course under construction. Examine the drainage system and physical soil conditioners being used. Ask the superintendent or construction engineer to discuss the irrigation system, seed mixtures, fertilization and liming, equipment and its uses, and job opportunities.
7. Visit a highway construction site. If possible, observe the seeding of highway banks and median strips. Discuss with the individuals in charge: seed mixtures, fertilization, and mulching. Also discuss operational skills, the use of equipment and job requirements.
8. Visit a home or commercial grounds where sod is being laid and arrange for the foreman to discuss the procedures followed.
9. Visit a sod farm and arrange for the manager to discuss the operations.

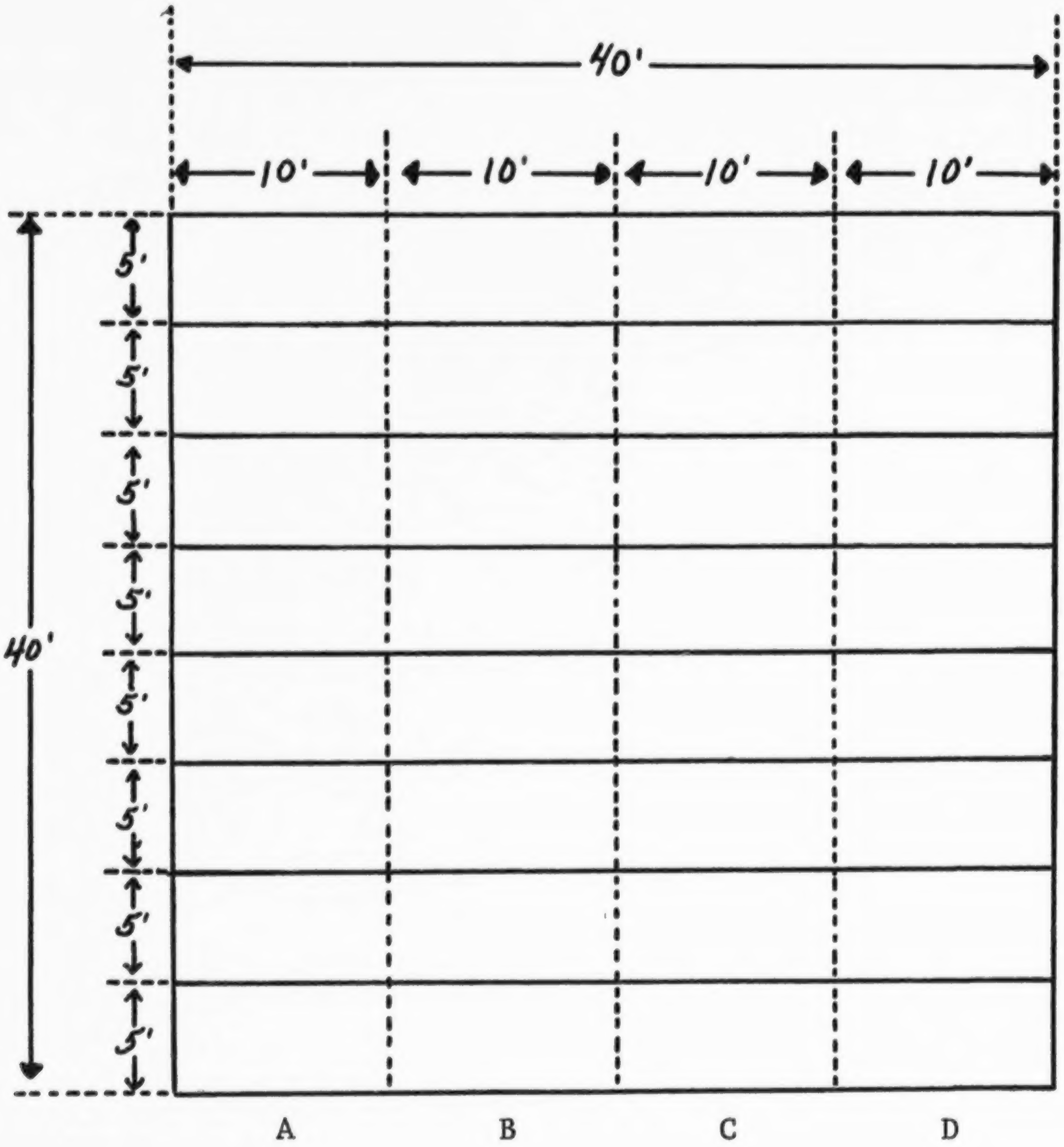
A turfgrass demonstration area will provide many learning activities. During the establishment of the plots, students will have an opportunity to: (1) take soil samples for testing; (2) calibrate spreaders and apply basic fertilizer and lime; (3) till soil to mix fertilizer, lime and amendments; (4) grade the plots; (5) apply starter fertilizer; (6) calibrate seeders and seeding; (7) cover seed and roll; (8) mulch and water; and (9) care for the new grass.

The plots may be used later to study maintenance practices such as mowing, fertilization, and weed and insect control.

To establish these plots, a soil test should be made. Lime and basic fertilizer are applied at the recommended rates and thoroughly mixed into the top 4 to 6 inches of soil with a dish or rotary hoe. The surface of the soil is smoothed by using a drag or raking. Starter fertilizer is applied at the rates shown on the diagram on page and raked into the top 1 to 2 inches of soil. Seed is applied at the prescribed rates and is covered by light raking. Light rolling places the seed in firm contact with the soil. See the Suggestions for Turfgrass Demonstration Plots on the following pages.

Suggestions for Turfgrass Demonstration Plots

Many combinations of treatments may be used to demonstrate various effects in turfgrass establishment and maintenance. The sketch below illustrates plots that could be used to demonstrate the effect of mowing height and maintenance applications of nitrogen fertilizer on different varieties of grass. A "slowly available," ureaform or natural organic course of nitrogen fertilizer should be used.



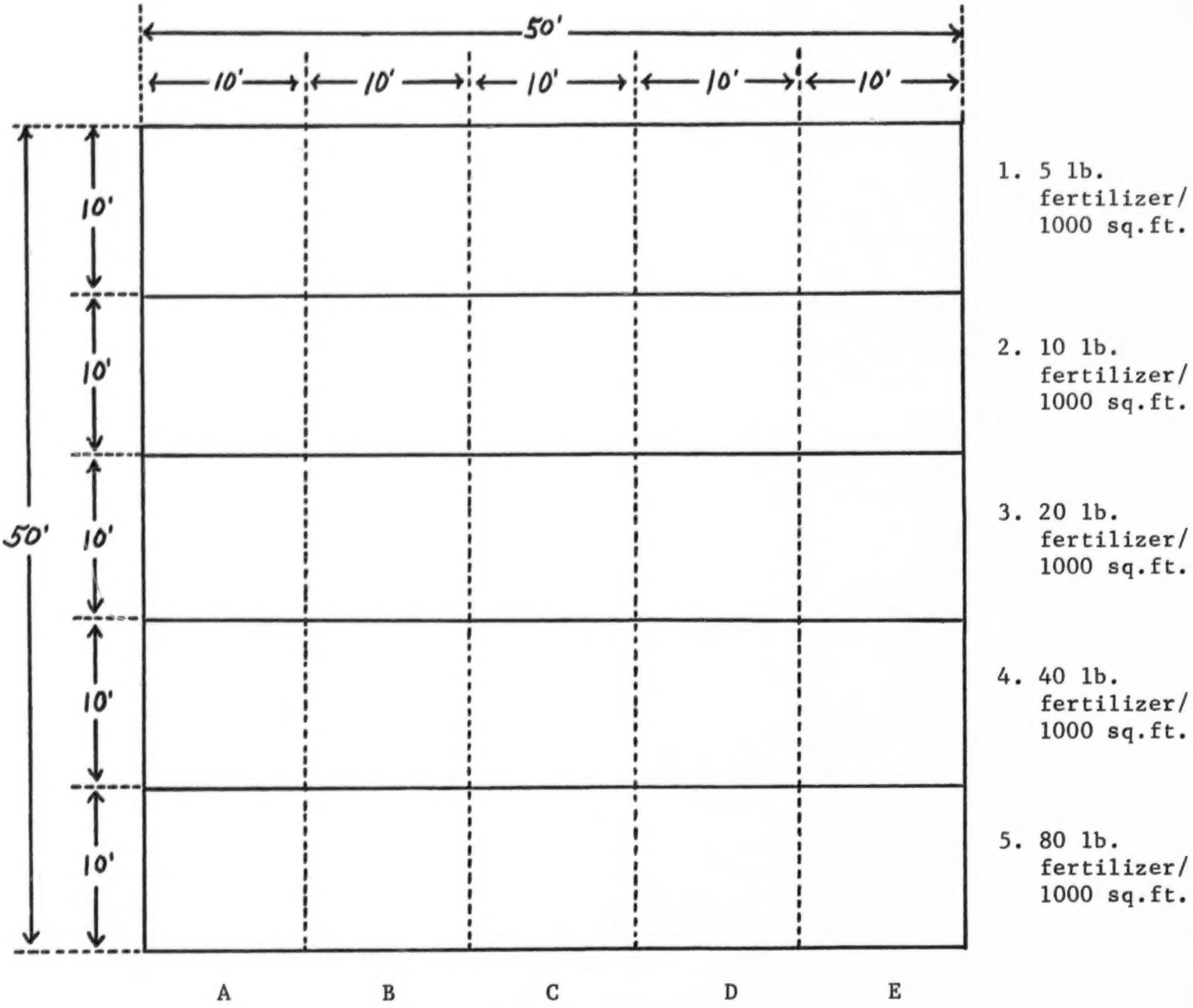
Variety

1. Common Kentucky Bluegrass
2. Merion Kentucky Bluegrass
3. Pennlawn Red Fescue
4. Kentucky 31 Tall Fescue
5. Redtop
6. Rough Bluegrass
7. Highland Colonial Bentgrass
8. Perennial Ryegrass

A. Mow at 3/4" height - Fertilize with 1 lb. N per 1000 sq.ft.
B. Mow at 3/4" height - Fertilize with 4 lb. N per 1000 sq.ft.
C. Mow at 1 1/2" height - Fertilize with 1 lb. N per 1000 sq.ft.
D. Mow at 1 1/2" height - Fertilize with 4 lb. N per 1000 sq.ft.

The suggested individual plot size is 5 ft. x 10 ft. The overall plot size would be 40 feet square. Plot corners should be marked in some manner - inverted soda bottles with the bottom flush with the soil surface are one possibility.

Another plot seeded to a good lawn seed mixture may be used to demonstrate variations in rates of applying starter fertilizer and in rates of seeding. A starter fertilizer with a 2:1:1 ratio and "quickly available" nitrogen should be used. The table below is based on the use of a 10:5:5 fertilizer or a similar analysis.


50'
10'
10'
10'
10'
10'
50'
10'
10'
10'
10'
10'
1. 5 lb. fertilizer/ 1000 sq.ft.
2. 10 lb. fertilizer/ 1000 sq.ft.
3. 20 lb. fertilizer/ 1000 sq.ft.
4. 40 lb. fertilizer/ 1000 sq.ft.
5. 80 lb. fertilizer/ 1000 sq.ft.
A
B
C
D
E

A. 1 lb. seed per 1000 sq.ft.
B. 2 lb. seed per 1000 sq.ft.
C. 4 lb. seed per 1000 sq.ft.
D. 8 lb. seed per 1000 sq.ft.
E. 16 lb. seed per 1000 sq.ft.

Overall plot size is 50 feet square. Each individual plot is 10 ft. x 10 ft. Plot sizes may be varied to meet local conditions.

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4. Careers in Ornamental Horticulture, 405 Centennial Building, Springfield, Illinois 62706.
5. Careers in Agribusiness and Industry, The Interstate Printers and Publishers, Inc., Danville, Illinois.
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The Pennsylvania State University

College of Agriculture
Department of Agricultural Education

University Park, Pennsylvania

TURFGRASS MAINTENANCE AND ESTABLISHMENT EXAMINATION

DIRECTIONS: Do not write on this test booklet. Use the separate answer sheet. Blacken out the letter of the most appropriate answer for each question.

1. The ideal soil for root development has:
   - a. 50% air space, 25% solid matter, and 25% water
   - b. 50% solid matter, 25% air space, and 25% water
   - c. 50% water, 25% air space, and 25% solid matter
   - d. 50% solid matter and 50% water
2. To prevent water accumulation in a tile line, a drop of:
   - a. 1 to 3 inches per 100 linear feet is required
   - b. 2 to 4 inches per 100 linear feet is required
   - c. 3 to 6 inches per 100 linear feet is required
   - d. 4 to 8 inches per 100 linear feet is required
3. Reed sedge peat and moss peat are organic materials especially recommended as soil physical conditioners because they:
   - a. decompose slowly
   - b. are easily incorporated
   - c. are not very costly
   - d. are readily available
4. Basic fertilizer for turfgrass establishment consists of:
   - a. phosphate materials
   - b. potash materials
   - c. phosphate and/or potash materials
   - d. nitrogen, phosphate, and potash materials
5. A starter fertilizer should include:
   - a. nitrogen and potash
   - b. nitrogen, phosphorus, and potash
   - c. nitrogen and phosphorus
   - d. phosphorus and/or potash
6. The form of lime recommended for use on turfgrass areas is:
   - a. ground limestone
   - b. burned lime (calcium oxide)
   - c. hydrated lime (calcium hydrate)
   - d. marl
7. The best pH range for most turfgrasses is:
   - a. 5.5 to 6.0
   - b. 6.0 to 6.5
   - c. 6.5 to 7.0
   - d. 7.0 to 7.5

8. Infiltration rate of water refers to the rate at which water moves:
    a. into the soil
    b. through the soil
    c. into the grass
    d. through the grass

9. The use of lime on a soil to correct acidity also:
    a. helps to improve drainage
    b. increases the availability of fertilizer nutrients
    c. controls grubs in the soil
    d. prevents fertilizer burn

10. Mulching with clean straw:
    a. covers the seed
    b. prevents wind erosion
    c. protects against excessive moisture evaporation
    d. prevents washing of seeds during rains

11. A term used to designate the minimum guaranteed percentages of nitrogen, available phosphate, and water soluble potash contained in a fertilizer is:
    a. nutrient level
    b. formula
    c. grade
    d. fertilizer analysis

12. The release of nitrogen from slowly available fertilizers depends partly on temperature and:
    a. amount of moisture in the soil
    b. the type of crop being grown
    c. activity of soil micro-organisms
    d. soil pH (acidity)

13. Whenever large amounts of sand and peat are used to alter the physical condition of the soil, it will be necessary to adjust certain maintenance practices. Two of these maintenance practices are:
    a. fertilization and mowing
    b. fertilization and spraying for weeds
    c. mowing and spraying for weeds
    d. fertilization and irrigation

14. Straw mulch should be completely removed from a newly seeded area when the grass:
    a. emerges from the ground
    b. is 1/2" to 1" high
    c. is 1" to 2" high
    d. is tall enough to be mowed

15. The best time to renovate a lawn is:
    a. late spring and early summer
    b. late summer and early fall
    c. either early spring or late fall
    d. either late spring or early fall

16. The minimum percentage of germination for most kinds of grass seed should be:
    a. above 75 percent
    b. above 80 percent
    c. above 85 percent
    d. above 90 percent

17. A grass used in mixtures for quick temporary cover for erosion control is:
    a. common Kentucky bluegrass
    b. Kentucky 31 tall fescue
    c. common ryegrass
    d. creeping bentgrass

18. Finely ground limestone:
    a. helps reduce acidity more rapidly than coarsely ground limestone
    b. is more effective as a fungicide than coarsely ground limestone
    c. is more effective in reducing the acidity of the subsoil
    d. is less expensive than agricultural grade

19. Drainage and irrigation systems are installed:
    a. before subgrading
    b. after subgrading but before final grading
    c. after final grading but before seeding
    d. either before subgrading or before final grading

20. Which is the best organic material to use as a physical conditioner for a turfgrass soil?
    a. manure
    b. sawdust
    c. peat
    d. cocoa hulls

21. Sod to be used for complete coverage of a turf area should be cut:
    - a. 1/4 to 1/2 inch thick
    - b. 1/2 to 3/4 inch thick
    - c. 3/4 to 1 inch thick
    - d. 1 to 1 1/4 inch thick

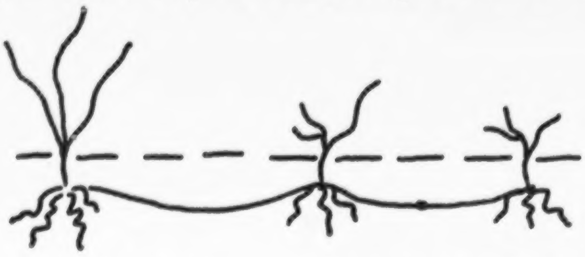
22. Most turfgrasses are mowed to a height of:
    - a. 1 to 1 1/2 inches
    - b. 1 1/2 to 2 inches
    - c. 2 to 2 1/2 inches
    - d. 2 1/2 to 3 inches

23. Sand and peat are mixed into soils used on golf greens and tees to:
    - a. provide nutrients
    - b. build resilience and resist compaction
    - c. promote deep rooting and provide nutrients
    - d. promote deep rooting and neutralize acidity

24. The cost per pound of nitrogen of a slowly available natural organic fertilizer is about:
    - a. 2 times the cost per pound of nitrogen in a ureaform fertilizer
    - b. 4 times the cost per pound of nitrogen in a ureaform fertilizer
    - c. 6 times the cost per pound of nitrogen in a ureaform fertilizer
    - d. 8 times the cost per pound of nitrogen in a ureaform fertilizer

25. Football gridirons and soccer fields are "crowned" to:
    - a. provide proper drainage of excess surface water
    - b. provide proper drainage of excess subsurface water
    - c. meet the rules of the game
    - d. reduce playing accidents

26. Identify the method of vegetative reproduction pictured below.
    - a. tillers
    - b. stolons
    - c. rhizomes
    - d. ligules



27. Points on the stem of a grass plant where leaves develop and grow are called:
    - a. axils
    - b. ligules
    - c. nodes
    - d. internodes

28. Perennial ryegrass is an example of a bunch grass. A bunch grass reproduces by:
    a. basal tillers
    b. rhizomes
    c. stolons
    d. seeds

29. Most bluegrasses spread by rhizomes. Which bluegrass spreads by long, slender stolons instead of rhizomes?
    a. Kentucky bluegrass
    b. Merion Kentucky bluegrass
    c. rough bluegrass
    d. annual bluegrass

30. Which grass has similar management requirements and usually is included with Kentucky bluegrass in lawn mixtures in the Northeast?
    a. rough bluegrass
    b. creeping red fescue
    c. annual bluegrass
    d. tall fescue

31. Which grass is often included in lawn seed mixtures because it quickly provides a temporary ground cover?
    a. annual bluegrass
    b. Kentucky bluegrass
    c. redtop
    d. creeping red fescue

32. Which species is used for temporary control of erosion on highway slopes?
    a. tall fescue
    b. crownvetch
    c. ryegrass
    d. bluegrass

33. Thatch is the result of:
    a. a nutrient deficiency
    b. insect damage
    c. poor soil drainage
    d. an accumulation of dead plant material

34. The main purpose of aerating a turf is to:
    - a. improve drainage
    - b. reduce surface compaction of the soil
    - c. get fertilizer to the plant roots
    - d. thin the turf

35. The amount of water that should be applied to a turf is determined by the:
    - a. number of days since the last watering
    - b. depth of water penetration into the soil
    - c. type of grass species found in the turf
    - d. condition of grass, time of day, and temperature

36. Which species is frequently recommended for nearly level highway median strips?
    - a. tall fescue
    - b. crownvetch
    - c. ryegrass
    - d. bluegrass

37. Vertical mowing is a cultural practice designed to:
    - a. correct the development of grain and thatch
    - b. correct the effects of over-fertilization
    - c. improve the putting condition of a golf green
    - d. renovate the old turf for reseeding

38. A light application of water is used to correct "temporary wilt" on golf greens. This practice is called:
    - a. syringing
    - b. sprinkling
    - c. wetting
    - d. damping-off

39. A chemical which retards the growth of plants and which is used on highway grasses to reduce the number of mowings is:
    - a. sodium arsenite
    - b. 2-4, 5T
    - c. cycocel
    - d. maleic hydrazide

40. Regular maintenance of athletic fields includes soil aeration:
    a. in the spring
    b. in the fall
    c. in the spring and fall
    d. after each game

41. In selecting a mowing height for golf fairways, consideration should be given to the maintenance requirements of the grass species and to playing conditions. Which of the following mowing heights would you select to meet both needs if the fairway was seeded primarily with Kentucky bluegrass?
    a. 3/4 to 1 inch
    b. 1 1/4 to 1 1/2 inch
    c. 1 3/4 to 2 inches
    d. 2 1/4 to 2 1/2 inches

42. The most common mowing height for bluegrass tees is:
    a. 1/2 of an inch
    b. 1 inch
    c. 1 1/2 inches
    d. 2 inches

43. Top-dressing is a golf-course cultural practice designed to:
    a. remove excessive water
    b. increase the soil fertility level
    c. control thatch and correct "grain"
    d. control grubs in the soil

44. The amounts of plant nutrients are noted on each bag of fertilizer. A fertilizer with an analysis of 10-6-4 contains:
    a. 10% N, 6% K_2O, and 4% P_2O_5
    b. 10 lb. N, 6 lb. K_2O, and 4 lb. P_2O_5
    c. 10% N, 6% P_2O_5, and 4% K_2O
    d. 10 lb.N, 6 lb. Phosphorous, and 4 lb. Potassium

45. "Grain" is a term used to describe a turf condition caused by:
    a. using a dull mower
    b. operating a mower too fast
    c. continued mowing in the same direction
    d. improper application of fertilizer

46. In which compound does some of the nitrogen become available more slowly to turfgrasses over a period of time?
    a. ammonium nitrate
    b. ammonium sulfate
    c. natural organics
    d. urea

47. Several insects may damage turfgrasses. The grayish-white, fleshy, worm-like pests which feed on the below ground parts of the grass plant are called:
    a. sod webworms
    b. nematodes
    c. chinch bug larvae
    d. grubs

48. The chemical 2,4-D is used for weed control. Which weed is not killed by 2,4-D?
    a. yellow rocket
    b. buckhorn
    c. crabgrass
    d. curly dock

49. Dandelion is a common perennial weed which is best controlled by:
    a. 2,4-D
    b. 2,4,5-T
    c. Silvex
    d. Mecoprop

50. A turf fungus disease which lives on organic materials in the soil and which appears in a circular pattern of darker green turf is called:
    a. dollar spot
    b. brown patch
    c. fairy ring
    d. nematodes

Name ______________________________ Date ______________________

Answer sheet for examination on Turfgrass Maintenance and Establishment

DIRECTIONS: Blacken out the letter of the best answer for each question.

1. [✓ a] b c d
2. a [✓ b] c d
3. a [✓ b] c d
4. a b c [✓ d]
5. a b [✓ c] d
6. a b [✓ c] d
7. a [✓ b] c d
8. a b c [✓ d]
9. [✓ a] b c d
10. a b c [✓ d]
11. a [✓ b] c d
12. [✓ a] b c d
13. a b [✓ c] d
14. a b [✓ c] d
15. a b c [✓ d]
16. a [✓ b] c d
17. a [✓ b] c d
18. a b c [✓ d]
19. a b [✓ c] d
20. a b [✓ c] d
21. [✓ a] b c d
22. [✓ a] b c d
23. a b c [✓ d]
24. a b [✓ c] d
25. a b c [✓ d]
26. a [✓ b] c d
27. [✓ a] b c d
28. a [✓ b] c d
29. [✓ a] b c d
30. a b [✓ c] d
31. a [✓ b] c d
32. [✓ a] b c d
33. [✓ a] b c d
34. a b c [✓ d]
35. a b [✓ c] d
36. a [✓ b] c d
37. a [✓ b] c d
38. [✓ a] b c d
39. a b c [✓ d]
40. [✓ a] b c d
41. a [✓ b] c d
42. a [✓ b] c d
43. [✓ a] b c d
44. a b [✓ c] d
45. a b [✓ c] d
46. a b [✓ c] d
47. a [✓ b] c d
48. [✓ a] b c d
49. a b c [✓ d]
50. a b [✓ c] d